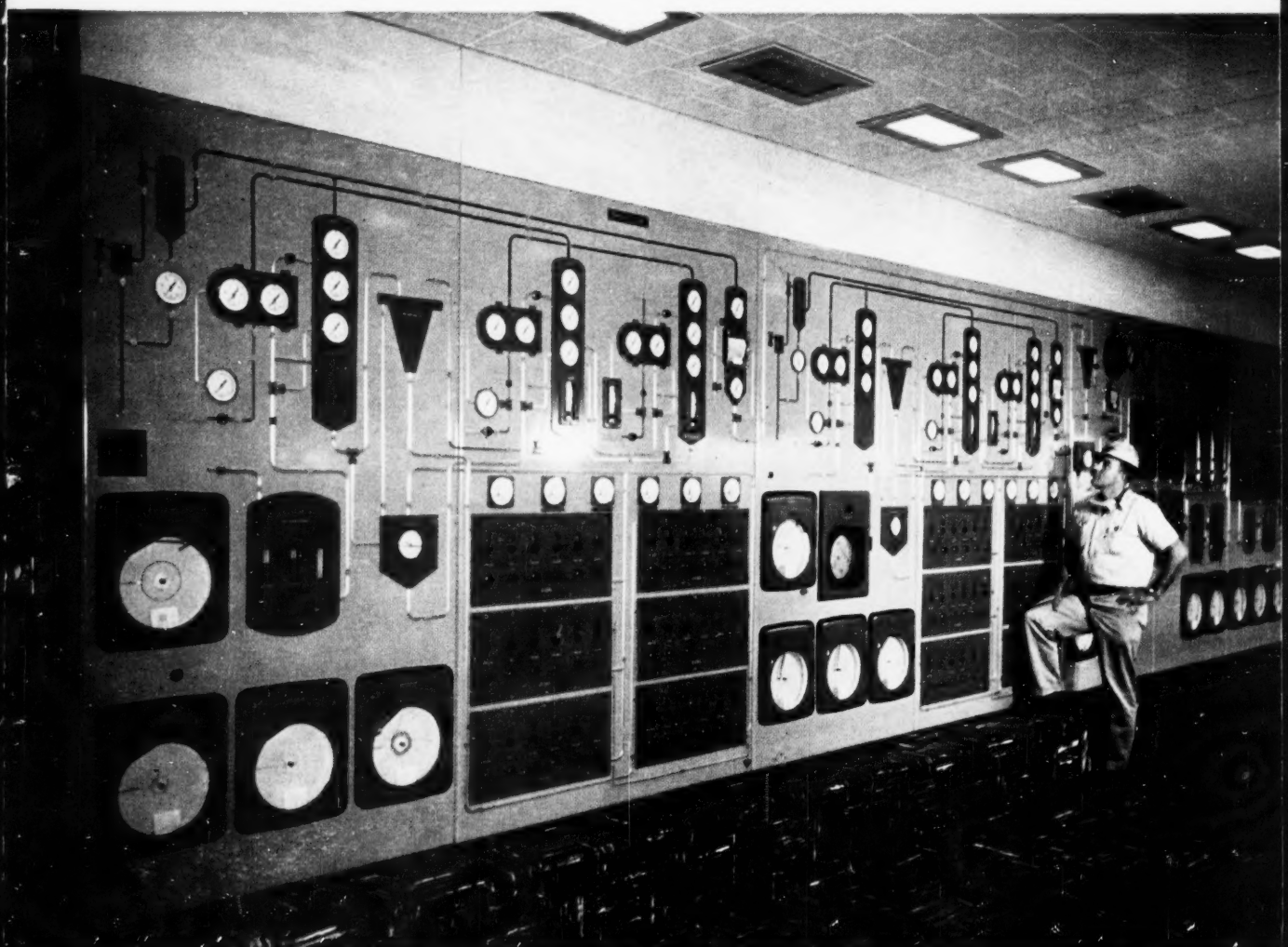
Instruments

THE MAGAZINE OF
MEASUREMENT · ANALYSIS · COMPUTING
INSPECTION · TESTING · CONTROL



Centralized Control Panel for completely automatic caustic evaporation and salt-separation plant of the Dow Chemical Company, Texas Division, Freeport, Texas. *(Photograph—by O'Connell, Dow—courtesy of Panellit, Inc.)*

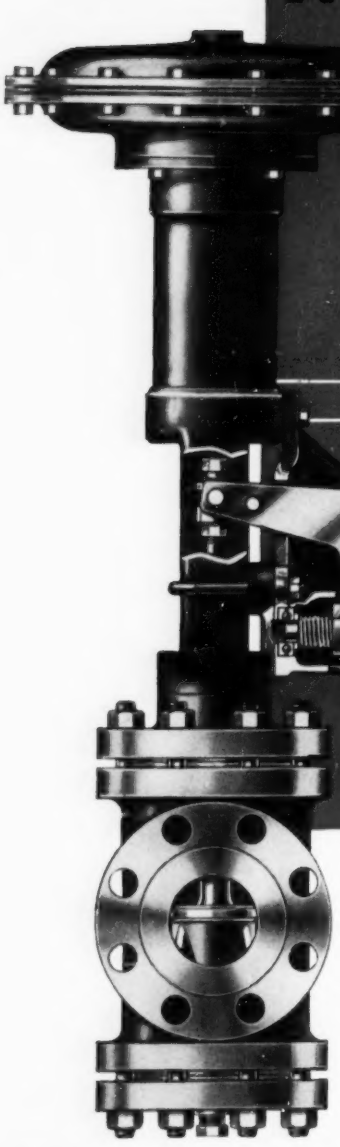
Including the
JOURNAL OF THE INSTRUMENT SOCIETY OF AMERICA (Page 261)

and the
JOURNAL OF THE SOUTHERN CALIFORNIA METER ASSOCIATION (Page 277)

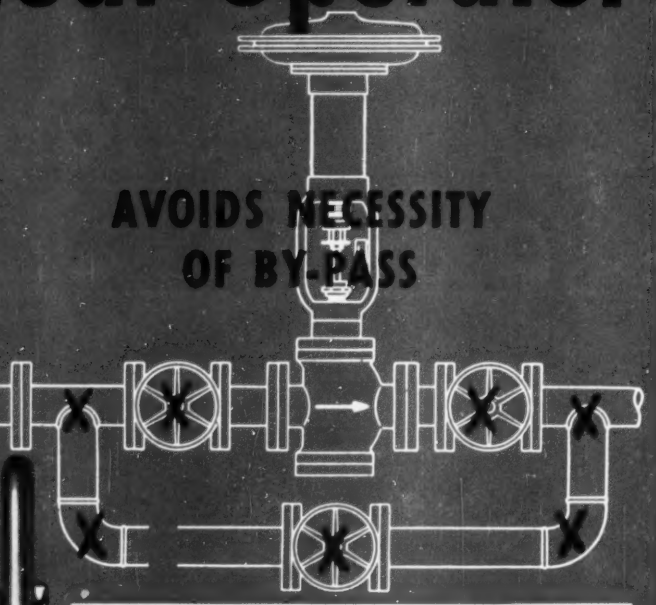
Vol. 26 No. 2
FEBRUARY • 1953

FISHER®

Type MO Manual Operator



Fisher Type 57-T diaphragm motor valve with side mounted Type MO handwheel operator in section.



In some applications it may be desirable or economical to place responsibility of the by-pass function upon the control valve. For these applications, select the Fisher Type MO. It is a simple, rugged, economical, continuous connected handwheel operator that will handle this problem.

DESIGN FEATURES

1. Manual operator may be used to override automatic operation.
2. The manual operator may be used as a travel stop. Valve may be set for automatic operation and manual operator adjusted to stop valve from completely opening or closing.
3. Manual operator in neutral position allows full pneumatic operation.
4. Diaphragm may be replaced while manual operator is used to control flow of fluid.
5. Manual operator is mounted on side of control valve for accessibility and ease of operation.

CONSTRUCTION FEATURES

1. Handwheel fitted with spring loaded ball and socket recess to retain wheel in position when not in operation.
2. May be mounted on control valves in field that have tapped bosses on yoke. Requires only new diaphragm rod, adjusting screw and stem connector.
3. Grease packed radial and thrust bearings insure long life and easy operation.
4. Handjack operating screw constructed with pitch to give adequate operating power.

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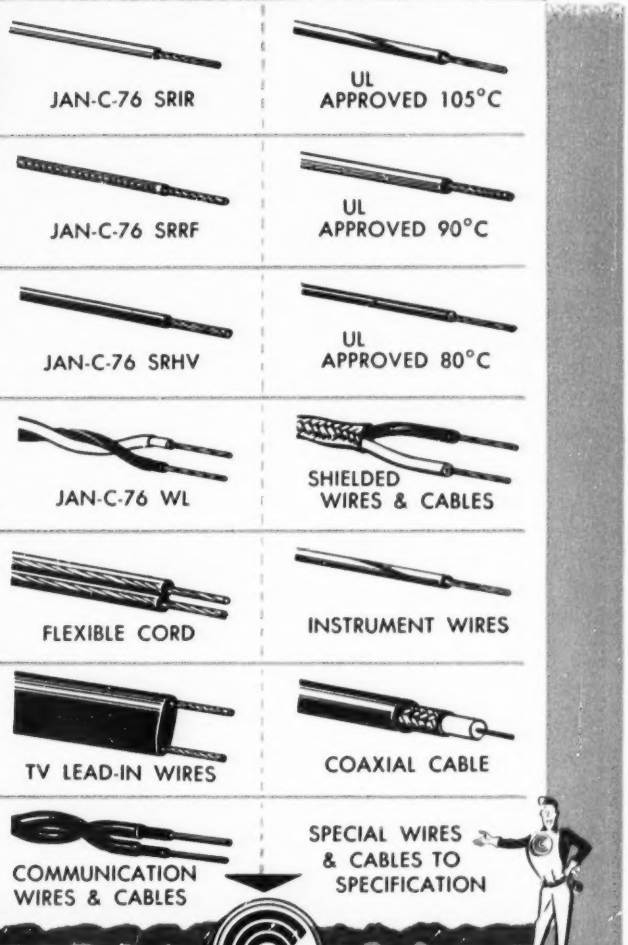

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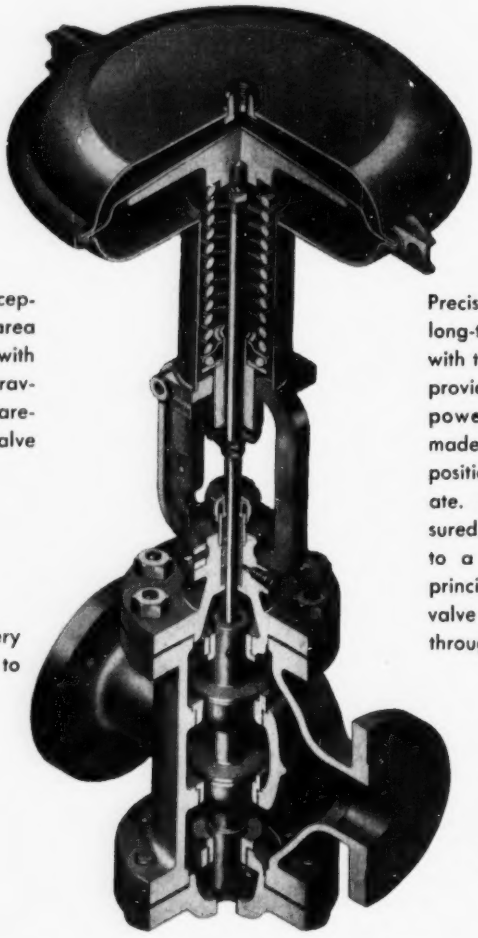

Molded diaphragm has exceptionally large effective area and maintains full contact with diaphragm button at all travels. The full benefit of carefully-engineered inner valve characteristic is assured.

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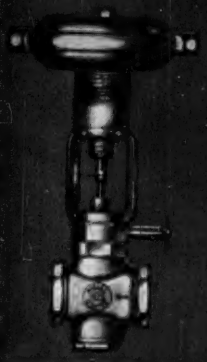
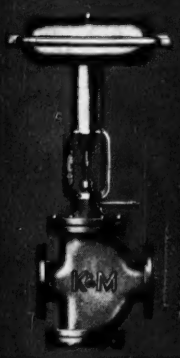


K&M Series 1000

Especially designed for applications which require "throttling" or narrow proportional band control action. Standard body material is bronze. Standard trim is bronze or 18-8 stainless steel. Other materials available.

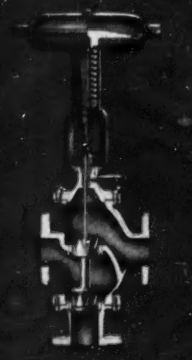
K&M Series 1550

Designed for service on all types of liquids, gases, steam, corrosive liquids or abrasive service. Available in globe pattern body with screwed or flanged end connections. Standard body material is cast iron, optional — cast brass, cast steel, stainless steel — carbon steel, plastic lined — also special alloys.



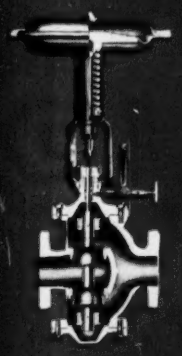
K&M Series 1200

For applications requiring a wide proportional band control action which warrants the combination skirt-guided angle valve. Standard body materials are cast iron, cast steel, carbon steel, or cast brass. Trim material is 18-8 stainless steel. Other materials available.



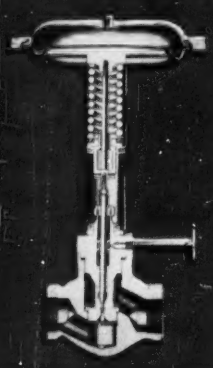
K&M Series 1700

A quick-way control valve for applications involving corrosive or abrasive liquids, gases, steam or slurries. Standard body materials are cast iron, cast steel, carbon steel, stainless steel, Monel, Hastelloy, Illium, Carpenter 20, Alloy 20. Also available in bronze or stainless steel.



K&M Series 1400

Designed for service which requires wide proportional band control action with top-and-bottom-guided skirt valves. Available in globe or angle pattern body — screwed, welding, or ASA flanged end connections. Body and trim materials same as series 1200.

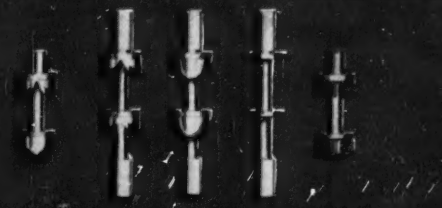


K&M Series 1850

Ruggedly constructed for severe services requiring working pressures up to 6000 psi at 1000°F. Available in angle or globe patterns with screwed or butt welded end connections. Standard body material is forged steel. Standard trim material is stainless steel; optional: stellite or other hard facing of trim.

K&M Series 1460

A sweep flow angle valve designed for applications involving flushing liquids, high pressure drops, cycling, or severe conditions. Available in angle pattern to 6000 psig, or 1500 psig construction. Flanged end connections. Standard body materials are steel or chrome molybdenum steel. Standard trim material is stainless steel, stellite faced.



K & M Control Valves

K & M control valves are available in sizes from ½ to 20 inches complete with diaphragm motors and are made in 11 different types with simple to heavy construction modifications.

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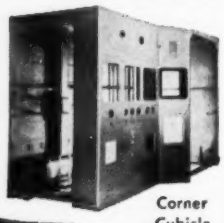
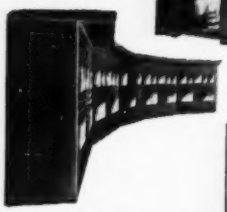


Five Section Cubicle Control Board and Lighting Canopy



Corner Cubicle Section

Refinery Cubicle with Mimic Flow Diagram in Color

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Instruments

THE MAGAZINE OF MEASUREMENT INSPECTION · TESTING · CONTROL

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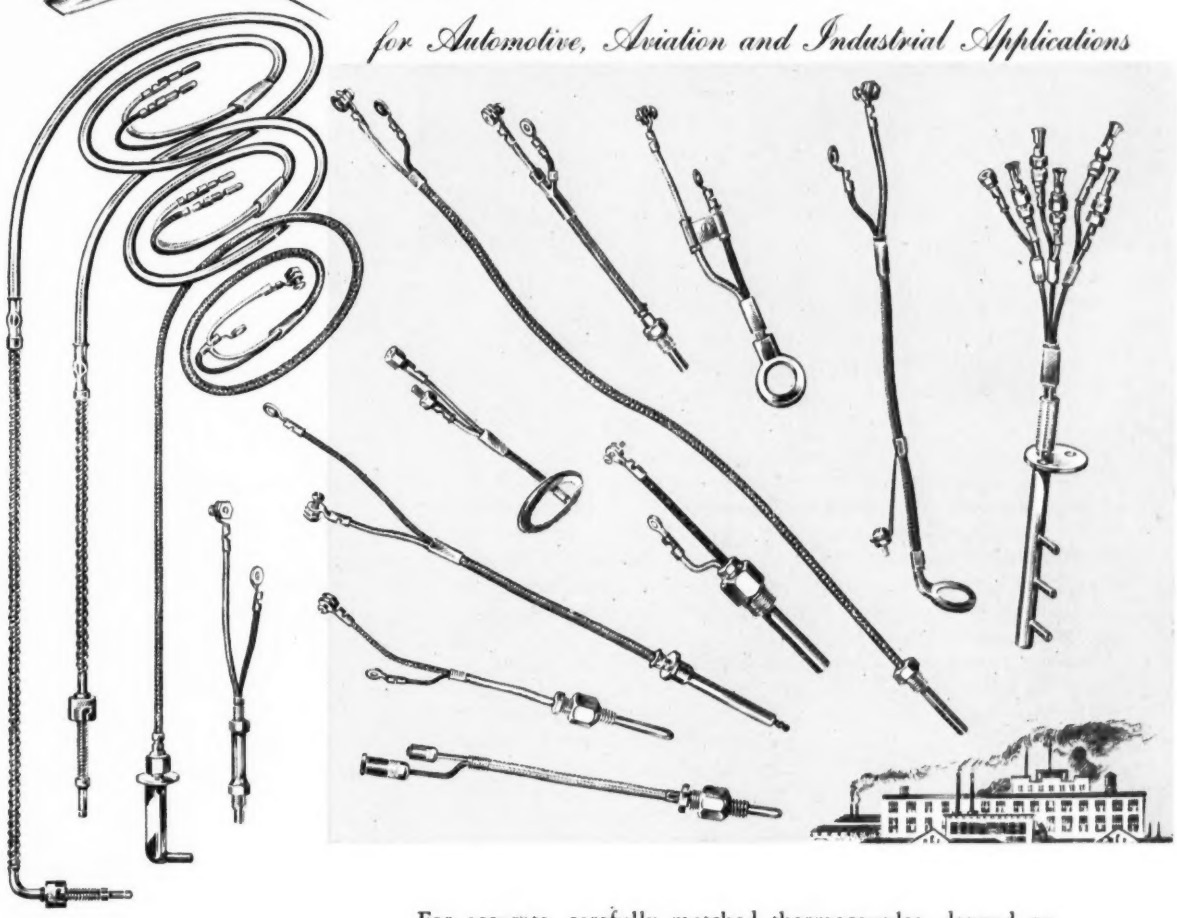

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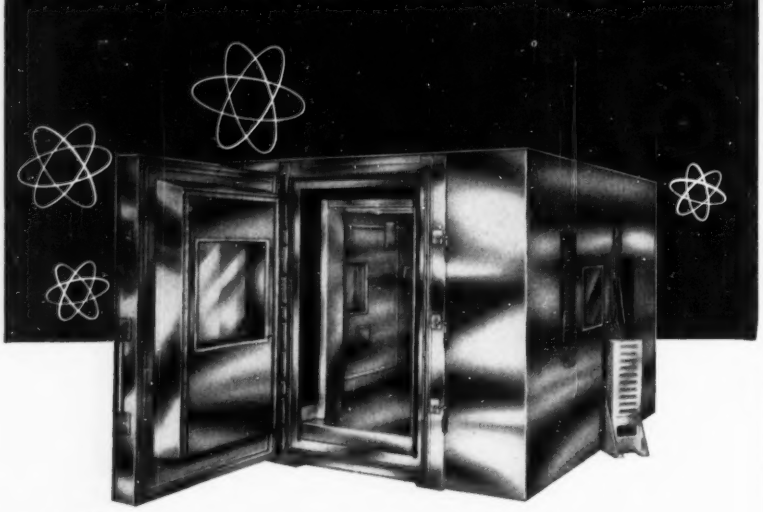

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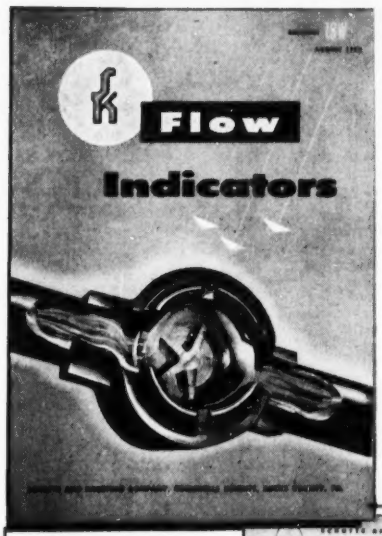


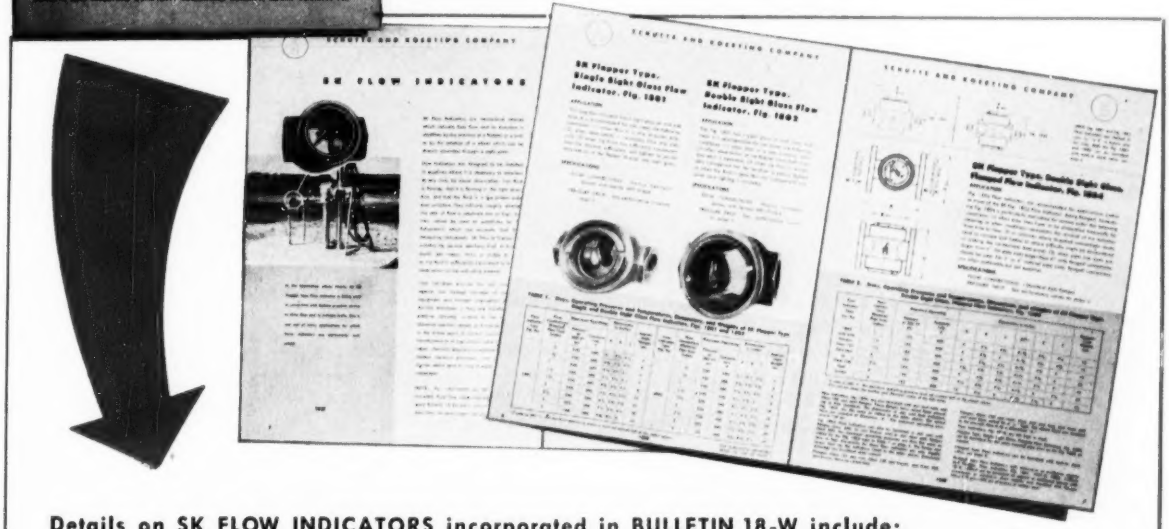
Design, Application, Operation of Flow Indicators Described In New Bulletin

Bulletin 18-W, illustrated at left, contains complete information on the many types of Flow Indicators manufactured by SK.

Flow Indicators, installed in pipelines, permit visual observation of fluid flow, direction of flow and flow conditions. These indicators are widely used throughout industry to prevent damage to valuable equipment.

SK Flow Indicators are suitable for service with any kind of fluid—liquid, gas, vapor, slurry, or sludge—provided the fluid is transparent enough to permit observation. They are designed to operate continuously—even under severe operating conditions—with minimum maintenance.

Request a copy of Bulletin 18-W for your files. It's a useful 12 page reference source.



Details on SK FLOW INDICATORS incorporated in BULLETIN 18-W include:

- **Design and construction features**
- **Materials of construction**
- **Tables of operating pressures, temperatures, dimensions**
- **Operating data**
- **Performance curve charts**
- **Ordering specifications**

NOTE: *For information on SK Rotameters, accurate fluid flow measuring instruments, request Bulletin 18-RA which pictures and briefly describes the many types manufactured by SK.*

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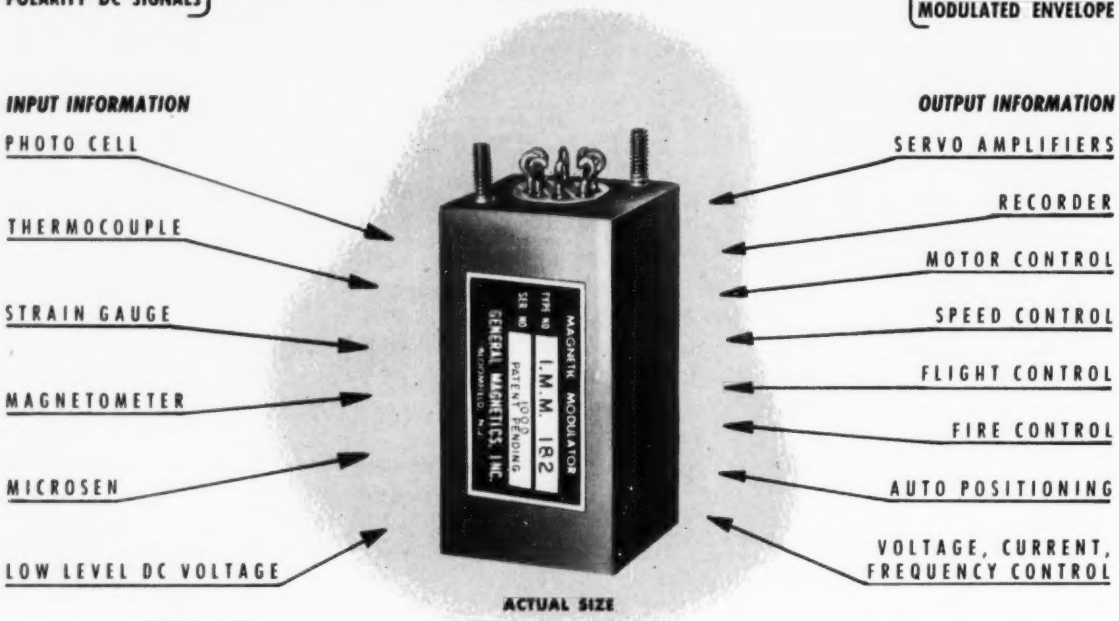

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Output at null—10 mv. rms. max.
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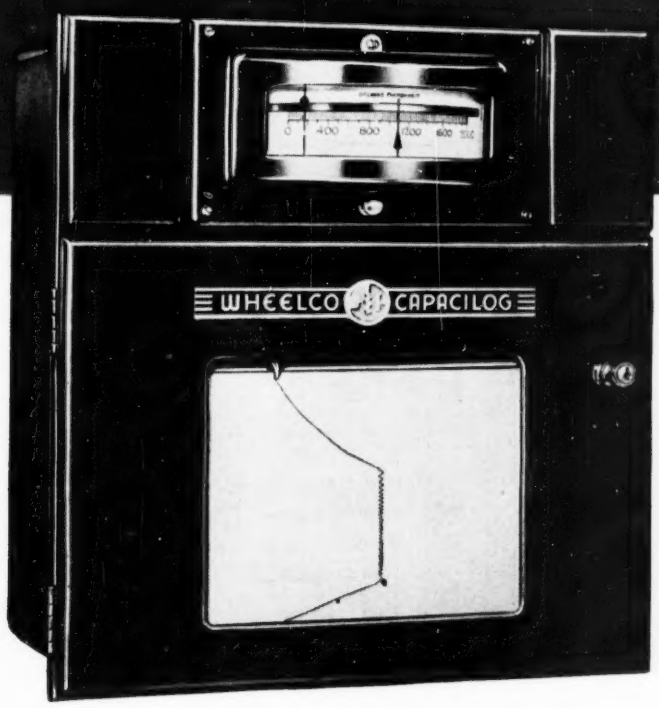

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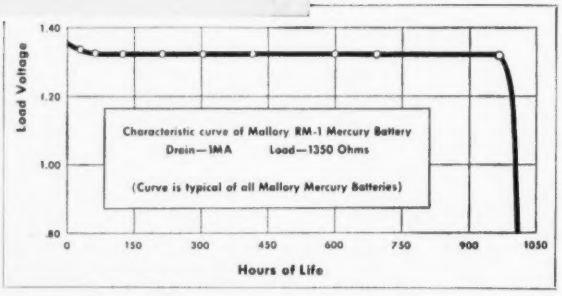

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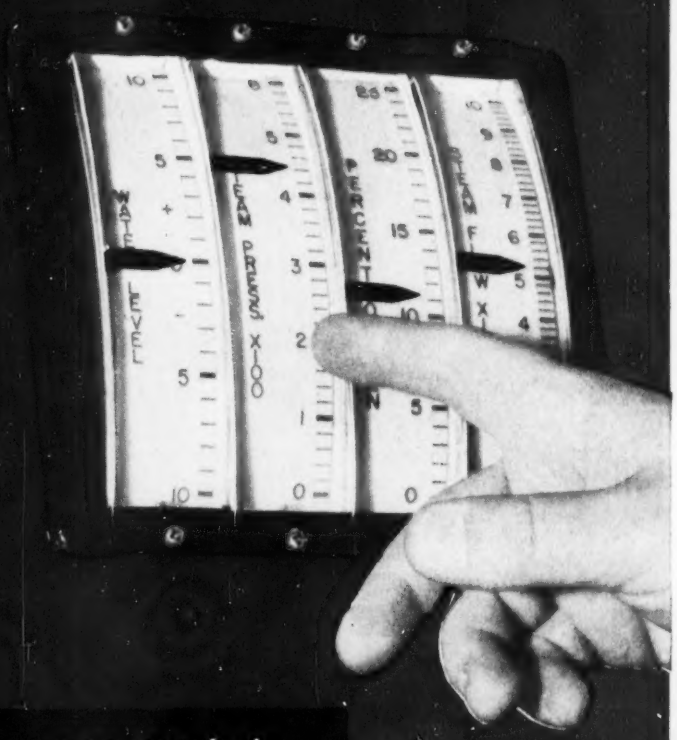


removable units—interior illumination

easy to read—5 inch scale, no parallax

easy correlation of related functions

easy zero check from the front

HAYS Miniscale Gages

This miniature instrument is especially suited for remote indication of such variables as pressure, draft, flow or level.

The scale is only 5 inches long — easy to read — internally illuminated. Choice of pneumatic or electric transmission.

Also available is the Hays direct reading miniscale gage for indicating *pressures* of fluids (steam, water, gas, oil, etc.) directly.

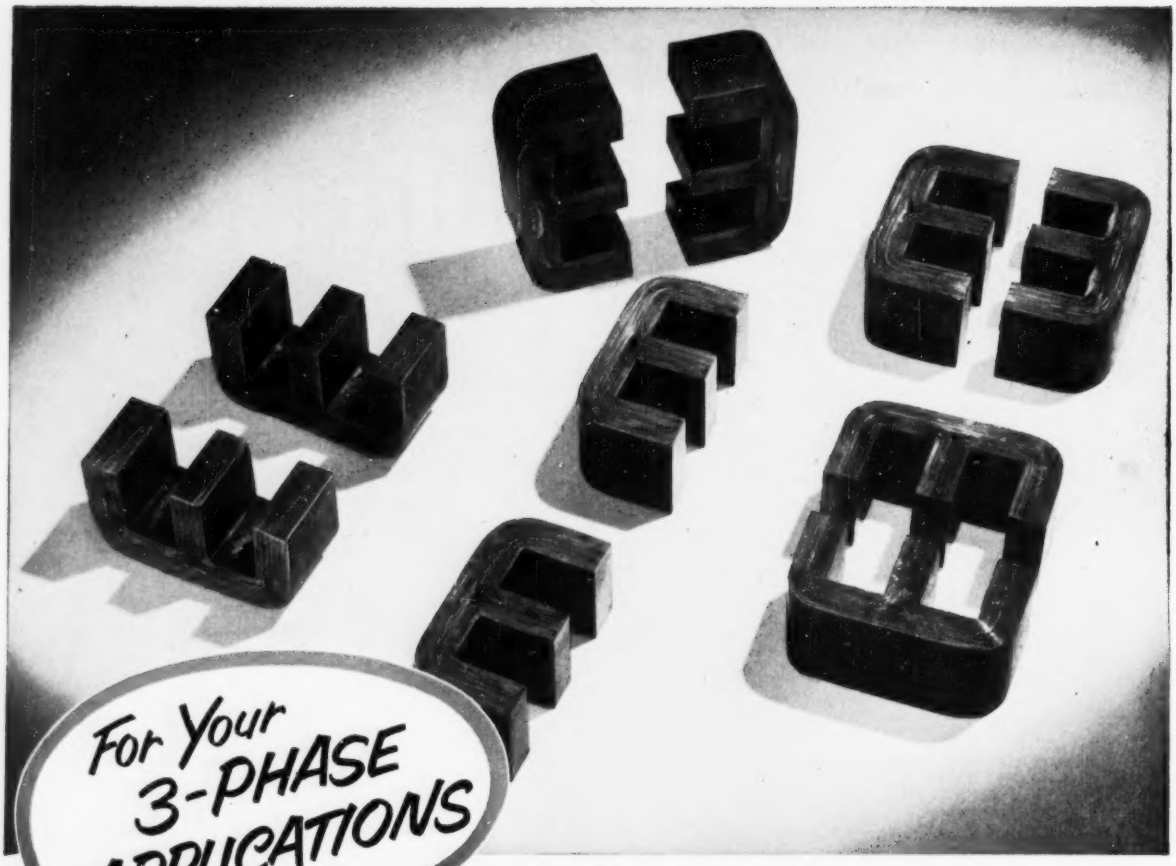
Gages are arranged for flush or semi-flush mounting. Either a yoke mounting, for as many as 12 units, or a keyhole clamp mounting for individual units can be provided.

Write today for full information on the Hays Miniscale Gages Bulletin 52-1075-223.

Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

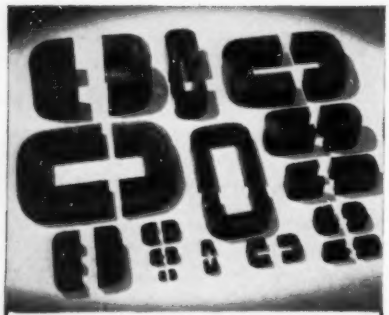
THE hays CORPORATION

MICHIGAN CITY 8, INDIANA



For Your 3-PHASE APPLICATIONS

Arnold E-CORES



C-Cores to meet any requirement

For your single-phase applications, Arnold "C"-Cores are available in any shape and quantity, and in any size from fractions of an ounce to hundreds of pounds . . . wound from Silectron strip in a wide range of ultra-thin and heavier gauges. (Sizes up to 10 lbs. in 12-mil strip; to any weight in thinner gauges.)

made from SILECTRON strip

(grain-oriented silicon steel)

The use of "E" cores, wound from grain-oriented silicon steel, results in weight and size reduction as well as higher efficiency and possible cost savings. "E" cores can be supplied in a variety of window sizes and core areas from 1, 2, 4 or 12-mil Silectron strip, for high or low frequency 3-phase applications. ● All Arnold cores are made by precision methods, and carefully tested under closely controlled conditions to assure highest quality and reliability. *We'll welcome your inquiries.*

W&D 4437

THE ARNOLD ENGINEERING COMPANY

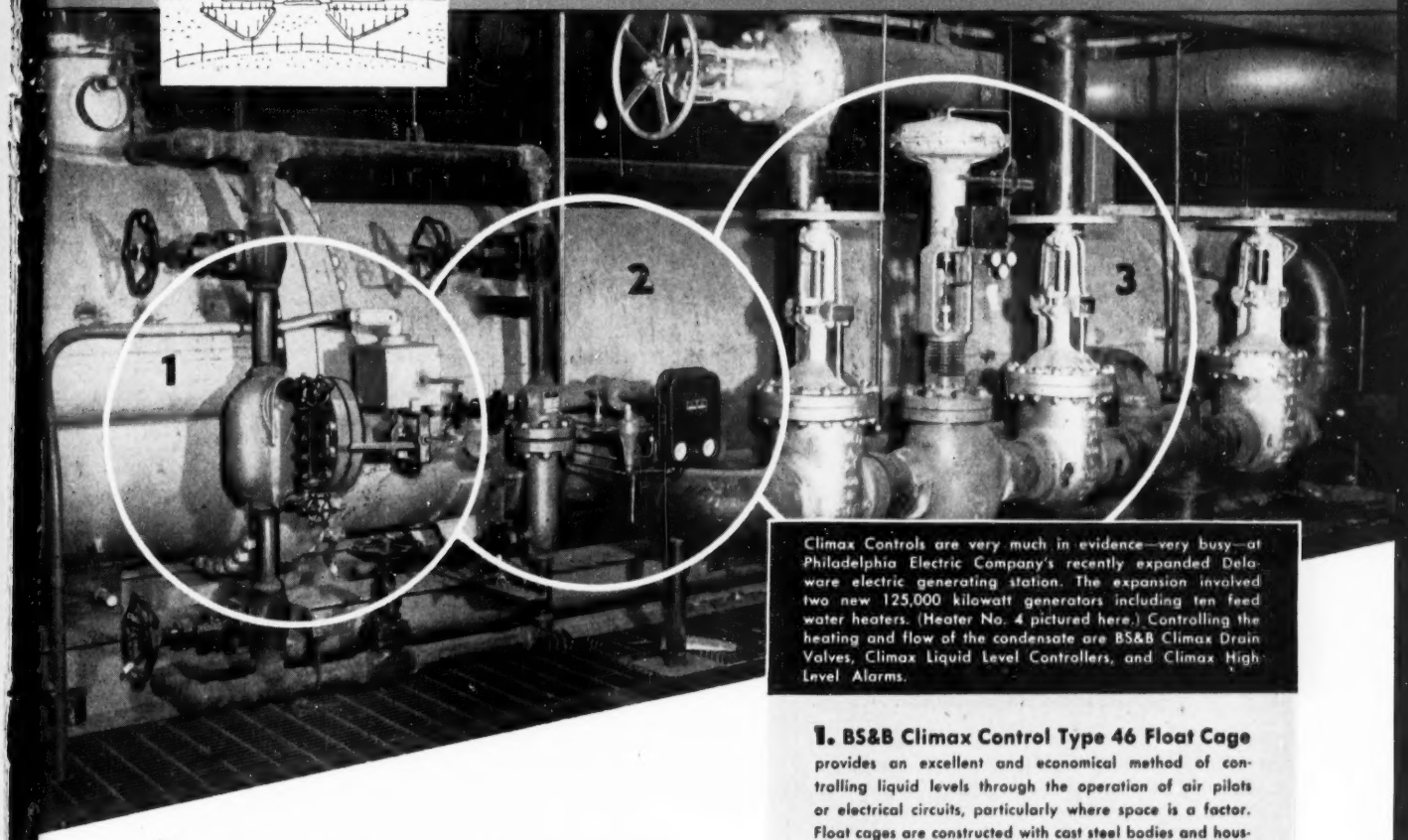
SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

More Kilowatts for Philadelphia . . .

More BS&B Climax Controls

faithfully serving the power industry



Climax Controls are very much in evidence—very busy—at Philadelphia Electric Company's recently expanded Delaware electric generating station. The expansion involved two new 125,000 kilowatt generators including ten feed water heaters. (Heater No. 4 pictured here.) Controlling the heating and flow of the condensate are BS&B Climax Drain Valves, Climax Liquid Level Controllers, and Climax High Level Alarms.

Climax Controls are precision instruments . . . completely relied upon by many precision minded industries. Over 12,000 different parts are manufactured for the assembly of various Climax Controls. Behind each part are years of instrument experience and knowledge and a particular *care* in fabrication. Every BS&B Climax Control is designed by men familiar with the industries using them. This protects your particular control application of pressures, temperatures, levels and flow.

1. BS&B Climax Control Type 46 Float Cage provides an excellent and economical method of controlling liquid levels through the operation of air pilots or electrical circuits, particularly where space is a factor. Float cages are constructed with cast steel bodies and housings for maximum pressures of either 500 or 1000 pounds.

2. The Torque Tube is the Heart of the BS&B Climax Liquid Level Controller. The ground cone head provides an absolute tight seal without using a gasket; also makes the tube easily adjusted. Climax is highly experienced in the design and application of torsion tubes. Inconel is used as standard torsion tube material because it satisfies the greater majority of services. Climax stocks other materials to meet certain corrosive conditions.

3. Here's the rugged, dependable BS&B Climax Diaphragm Control Valve. Typical of BS&B's versatility and ability to adapt equipment to needs and conditions is this Type 86 with finned section shown here. When temperatures above 450° F are encountered in the flowing medium, through any Type 86, it is advisable to insert this steel finned section between the valve body and the stuffing box assembly . . . thus insuring proper packing lubrication and cooler stuffing box operation.

CLIMAX BS&B CONTROLS OUR 60TH YEAR

BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division, Dept. 4-V2

7500 East 12th Street — Kansas City 26, Missouri

- in design, construction, and performance.
- in sensitivity, linearity, and balance.
- in all the minute details that make an outstanding instrument.

DOELCAM RATE MEASURING

GYROSCOPES

For complete details write for Bulletin K

DOELCAM CORPORATION

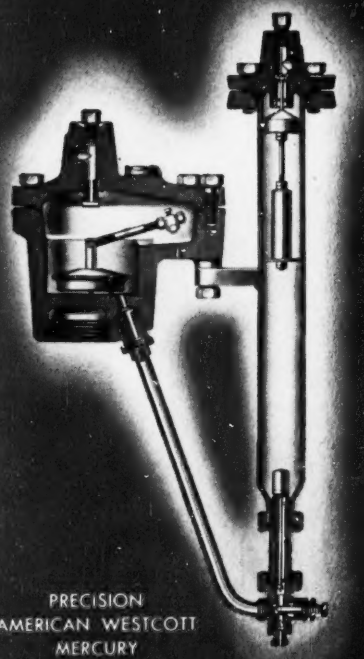
1400 Soldiers Field Road, Boston 35, Mass.

Instruments for Measurement and Control

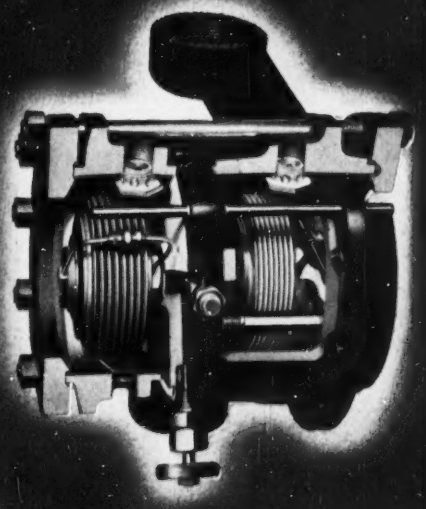
GYROSCOPIC INSTRUMENTATION • SYNCHROS • SERVOMECHANISMS • MICROSYNS • ELECTRONIC INVERTERS

AMERICAN®

offers you TWO BASIC MEASURING INSTRUMENTS



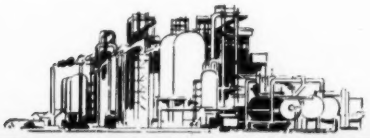
PRECISION
AMERICAN WESTCOTT
MERCURY
ORIFICE METERS

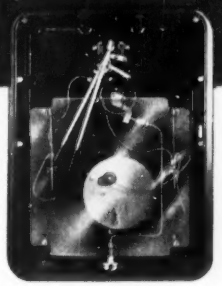


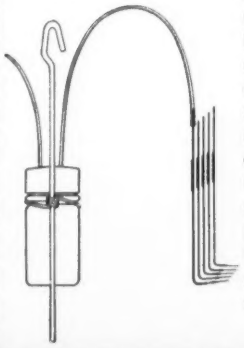
PRECISION
AMERICAN DRI-FLO
MERCURYLESS
ORIFICE METERS

Your specific requirements for differential pressure measurement will be met with one of these two field proven instruments. Both types are designed to reduce installation and operation problems. Both combine the extreme accuracy, dependability and low maintenance characteristic of all American equipment built under a long-time tradition of "Sustained Accuracy at Lower Cost."

Write for Details







CANNON METER PENS
(Formerly Chartomatic)
FOR ALL TYPES OF RECORDING INSTRUMENTS

Now, American and other types of recording instruments may be equipped with Cannon controlled-flow Meter Pens, if desired. Stainless steel pens are capillary fed by upward flow from a half-ounce reservoir holding and protecting up to a year's supply of ink. These instruments provide maximum legibility and reduce meter inking problems to the bare minimum. They are unaffected by pulsating flows, rapid pen movement, or atmospheric fluctuations and are non-clogging. Available in various styles for all standard recording instruments.

AMERICAN METER COMPANY
(INCORPORATED ESTABLISHED 1892)

AMERICAN METER CO EST. 1892

GENERAL SALES OFFICE: 1513 Race Street, Philadelphia
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Houston • Kansas City • Los Angeles • Minneapolis
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Hamilton, Ontario • Edmonton, Alberta

A Superior Controller

must be readily adaptable

FIELD MOUNTED
THE FLEXIBILITY OF THE CONTROLLER TYPIFIES
P-4 PNEUMATROL

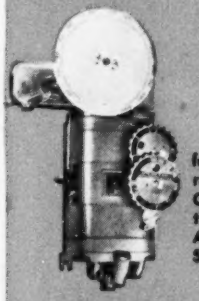
The "building block" design and construction of Fischer & Porter P-4 Pneumatrol units provides the maximum in versatility of use. These design features permit ready change of a case mounted Pneumatrol into a field mounted controller by the mere addition of pre-built, basic elements. This unique feature of the P-4 assures minimum spare parts inventory and simplifies servicing.

The P-485 field mounted controller combines the best features of force and motion balance controllers by the unique application of paired bellows elements for precision, speed and permanence. It is the fastest field mounted controller and yet has completely stable high frequency response. P-4 Pneumatrol units are extremely compact in size, simple in operation and completely corrosion resistant.

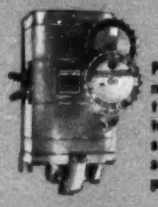
The plug-in type companion manifold has been just as thoroughly designed as the P-4 and includes built-in cut-off relay, automatic output cut-off below 1 psi setting pressure, positive self-sealing ports with unusually large air passages to prevent degrading the control response.

F&P P-4 Pneumatrol flow controllers are extremely versatile in their application. Complete information is yours for the asking. Write today!

P-485 FIELD MOUNTED CONTROLLER
(Proportional, Reset, Derivative) with plug-in air connections. Mounting plate includes shutoff relay and air check valves.

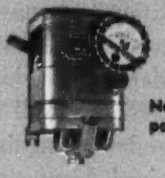


P-475 FLOW RATIO CONTROLLER
for wide range flow ratio requirements. Optional construction provides VARIABLE PNEUMATIC SET CONTROL.

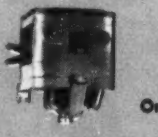


P-45 CASE MOUNTED CONTROLLER
Proportional, Automatic Reset. Derivative Action obtained by installing snap-in resistor assembly below proportional dial.

P-43M CASE MOUNTED CONTROLLER
Wide band proportional with manual reset.



P-42 CASE MOUNTED CONTROLLER
Narrow band proportional.



P-41 CASE MOUNTED CONTROLLER
On-off action.

Temperature compensated precise pneumatic transmitter—a special form of the P-4 Pneumatrol utilizing many features.

FISCHER & PORTER CO.

© 2055

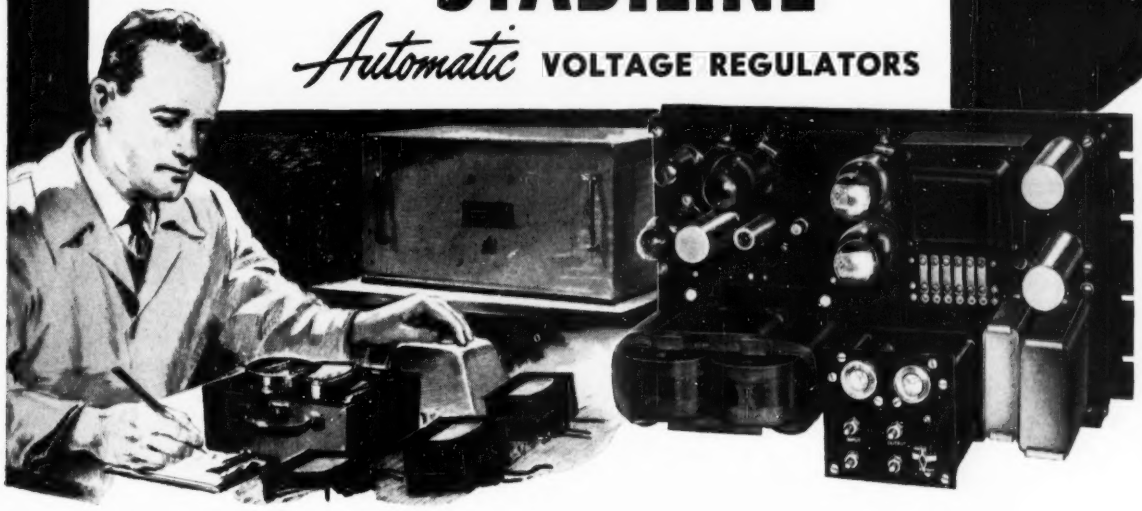
1320 County Line Road, Hatboro, Penna.

sci'ence (si'ens), n.(OF., fr. L. scire (to know)

--and knowing the advantages of automatic voltage regulation, this man depends on

STABILINE

Automatic VOLTAGE REGULATORS



Scientific developments are based on EXACT knowledge. To obtain exact data in tests involving electrical circuitry, input voltages must remain constant. To insure dependable, accurate results . . . to eliminate the need for rerunning experiments because a change in input voltage has invalidated the first run . . . depend on a STABILINE Automatic Voltage Regulator to maintain constant voltage regardless of line or load changes.

Offering the finest in automatic voltage regulation equipment, The Superior Electric Company offers two types of STABILINE Automatic Voltage Regulators. Type IE (Instantaneous Electronic) is completely electronic with no moving parts. Correction — when compared with other types — may be considered instantaneous. Regulation and stabilization are excellent; maximum change in output voltage will not exceed ¼ of 1% for any or all variations in operating conditions. Waveform distortion never exceeds 3%.

Type EM (Electro Mechanical) is an electro-mechanical device with inherent characteristics of zero waveform distortion, high efficiency and faster correction than most types of automatic voltage regulators. It is ideal for controlling large industrial loads. Both types are available in numerous capacities and ratings.

SPECIAL MODELS of STABILINE Automatic Voltage Regulators can be supplied to meet individual requirements. Specializing exclusively in the design, development and manufacture of voltage control equipment, The Superior Electric Company is thoroughly experienced to help you in studying your exact needs and recommending the right equipment to serve you best.

FOR ENGINEERING INFORMATION and CATALOG, WRITE TO 702 MAE AVENUE

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

- POWERSTAT LIGHT DIMMING EQUIPMENT
- STABILINE AUTOMATIC VOLTAGE REGULATORS
- 5-WAY BINDING POSTS
- VOLTBOX A-C POWER SUPPLIES
- POWERSTAT VARIABLE TRANSFORMERS
- VARICELL D-C POWER SUPPLIES

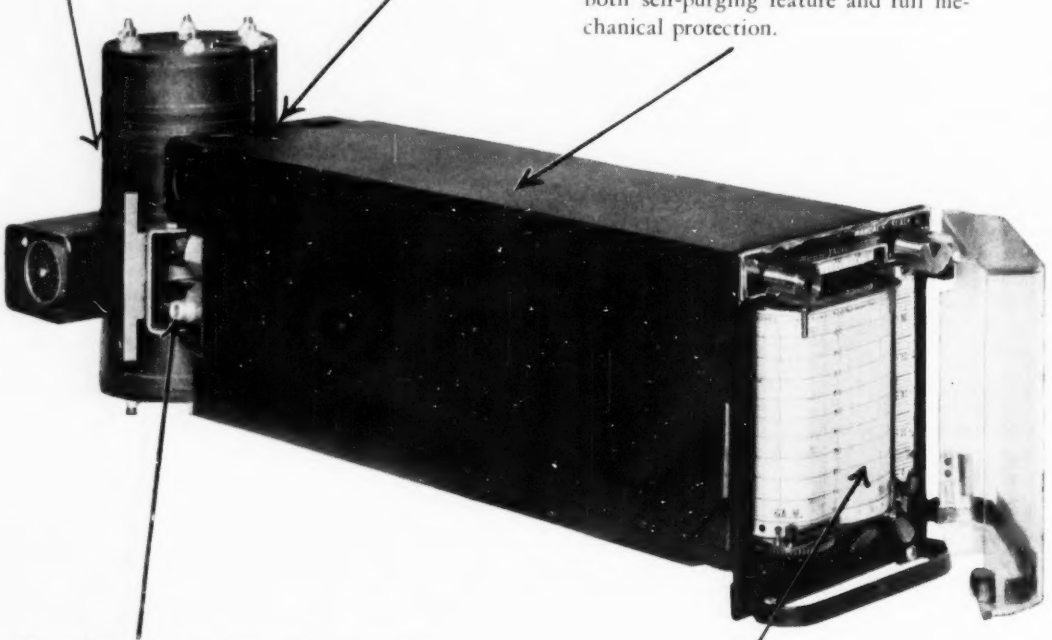
The new Taylor idea in

RECEIVER MECHANISMS KEPT CLEAN BY SELF-PURGING FEATURE!

The plug-in controllers can be removed and replaced with another unit in just 10 seconds.

One common, self-sealing manifold gives plug-in connections to both receivers and controllers!

Rugged steel sleeve clamps on panel, without welding or drilling. Permits both self-purging feature and full mechanical protection.



The only piping on the panel back are lines from the transmitter, air supply and controller output. Units can be mounted just a few inches apart.

Recorder or indicator plugs in from the front—units can be interchanged in just 10 seconds.

Panel Instrumentation!

BOTH RECEIVER AND CONTROLLER PLUG IN LIKE A RADIO TUBE!

Continuous, trouble-free performance assured even in difficult atmospheres

CORROSIVE atmospheres, dust or fly ash can't get into the mechanism of Taylor's Transet Receivers because the protective case or sleeve is *self purging.* Even the simplest receiver can be provided with the self-purging feature. In fact, the Transet receivers have corrosion-resistant qualities comparable with those of the well known FULSCOPE* line of controllers, thus making them completely suitable for all industrial service. Both Receivers and Controllers plug in like a radio tube. You can change from the simplest to the most complete control by simply pulling out one unit, plugging in another.

NOTE THESE FEATURES TOO

A single mounting is all you need for both controller and recorder or indicator. *All units* can be mounted on the panel without welding, without drilling holes. And you can change from indicator to recorder, or vice versa, in only 10 seconds.

Protective sleeve or case permits both self-purging feature as well as complete mechanical protection to receiver mechanism.

The only piping connections required are air supply, controller output and to the variable transmitter. All other connections are made automatically, in the self-sealing manifold.

All adjustments on recorder or indicator can be reached conveniently, from the front, without disturbing any connections.

You save panel space, because units can be mounted only a few inches apart. **You save money,** both in labor and materials on installation, thanks to the simplified piping and mounting.

Continuous valve position indication on separate scale tells valve air pressure at a glance.

Chart read-back device gives easy access to past records without disturbing any function of the recorder or interrupting the record.

A new chart drive mechanism for greater convenience, greater dependability.

Thanks to its corrosion and dust-proof qualities, this plug-in-type Taylor TRANSET* Control System is particularly suitable for use in chemical industries and refineries. Call in your Taylor Field Engineer, or write for full information. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

▼ ▼ ▼

Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

*Reg. U. S. Pat. Off.

Taylor Instruments

MEAN

ACCURACY FIRST

IN HOME AND INDUSTRY

New Bristol Series 650

PNEUMATIC TRANSMITTERS

for use with Bristol Miniature Recorders, Indicators, and Controllers . . . give you new standards of accuracy!

Get unexcelled precision in measuring and transmitting readings of temperature, pressure, vacuum, differential pressure and liquid level. • Non-bleed booster pilot ensures low air consumption; in the balanced position air consumption is only 0.07 scfm. • High-speed transmission and superior control result from large air capacity of the pneumatic relay—3.0 scfm. • Indicating dial gauge, showing output pressure, is easily screwed into the front of the transmitter, allowing local readings.

Available in a wide selection of temperature, liquid level, pressure, vacuum, and differential pressure ranges, the Series 650 Pneumatic Transmitter will help you measure and control every step in your manufacturing processes. Write for free bulletin, No. A105. The Bristol Company, 113 Bristol Rd., Waterbury 20, Connecticut.

LOOK FOR NEW THINGS FROM BRISTOL

BRISTOL

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

WHAT'S NEW AT

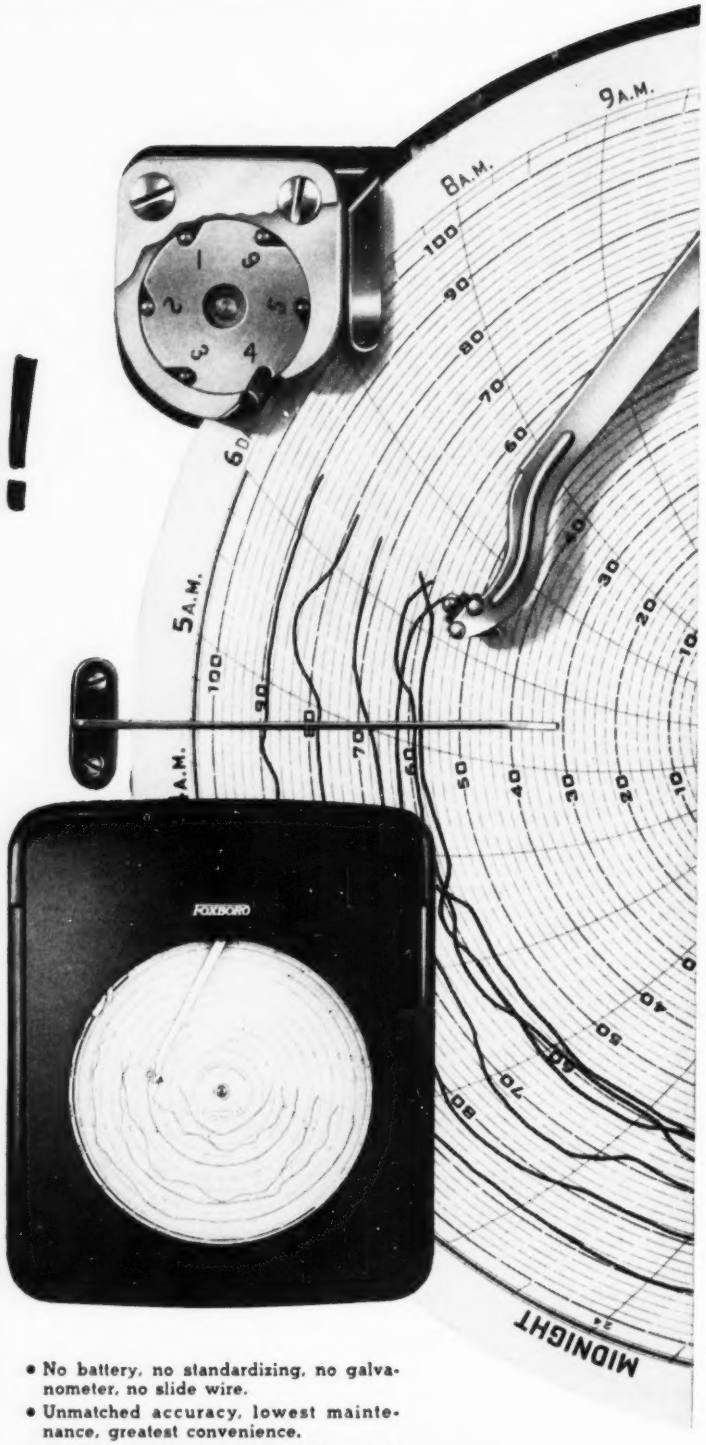
Weighs only 7½ lbs—is weatherproof—can be installed in any location—and will operate in any position.

THE DEPENDABLE GUIDEPOST OF INDUSTRY

3.11

What a record!

...6 Color-coded Temperature Records on one ROUND Chart



THE MULTI-RECORD DYNALOG*

What convenience! What economy! You can record up to 6 related temperatures on a single *circular* chart with this Foxboro Multi-Record Dynalog. Not only saves panel space, but simplifies comparison of records. There's only one pen arm — yet all 6 records appear in different, distinctive colors. Bulletin 427-1 tells the complete story. (Bulletin 444 describes the Multi-Record *Pneumatic* Receiver). Write for your copy. The Foxboro Company, 462 Neponset Ave., Foxboro, Mass., U.S.A.

*Reg. U. S. Pat. Off

Check these outstanding features

- High speed recording — only 6 seconds between prints for quick detection of process variations.
- Uses convenient, low cost circular charts.
- Each record line has its own distinctive, non-smudging color.
- No battery, no standardizing, no galvanometer, no slide wire.
- Unmatched accuracy, lowest maintenance, greatest convenience.
- Available with alarms or on-off control.
- Thermocouple or resistance-bulb types.

FOXBORO REG. U. S. PAT. OFF. — MULTI-RECORD DYNALOG

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

STAYNEW FILTERS' DOUBLE ACTION

Guards Against Water, Oil and Pipe Scale

MECHANICAL SEPARATION

1. Deflector cup directs flow of air or gas together with water, oil and dirt to the walls of the housing and then downward at high velocity into the base where liquid and heavier dirt particles are deposited.

FILTRATION

2. Air or gas, having been mechanically cleaned, rises at low velocity through the Radial Finned Filtering element or insert which removes the lighter air-borne material.

MODEL CPH
PIPE LINE FILTER

This exclusive Double-Action principle of Staynew Pipe Line Filters assures sustained, trouble-free operation. Inexpensive, quickly installed and easily maintained, these filters keep air operated or controlled equipment free from pipe scale, dust, dirt, and condensate. Wherever you require air and other gases *clean* and *dry*—demand and get—Staynew Pipe Line Filters.

Write today for complete Staynew Pipe Line Filter Bulletin B-1A.

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DOLLINGER
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STAYNEW FILTERS

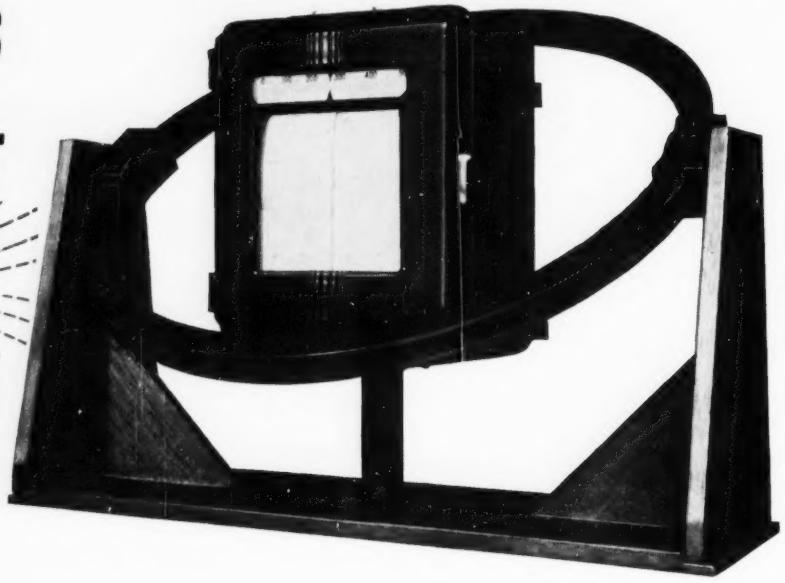
DOLLINGER CORPORATION

63 Centre Pk., Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED

Here's how L&N engineers verify Speedomax resistance to stray electrical fields. The ring is a Helmholtz coil, adjustable for a wide variety of field effects.

Speedomax is engineered for FIELD service



● Built into every Speedomax recorder and controller is a high degree of indifference to stray electrical fields. And this is one of its most useful characteristics in almost any job. It means that you can install a Speedomax near a big motor, power line or X-Ray machine—any electrical equipment in fact—and you'll probably see no effect at all from surrounding electronic noise and "junk".

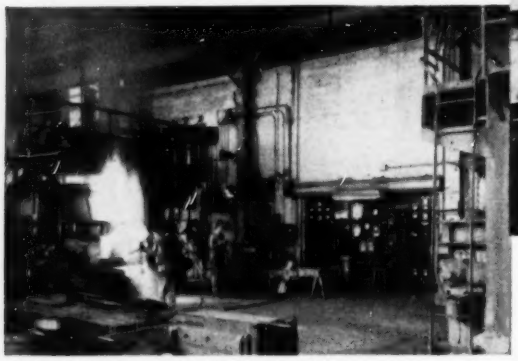
The reason for this indifference to stray fields goes back through the adjustment, building and design of the instrument, to its basic engineering. Speedomax has an *electronically-clean measuring circuit*, as well as clean signal and amplifier circuits.

This clean design includes a bifilar-effect slidewire, to eliminate any objectionable inductance at that point. It includes our "no-moving parts" trolley contact on the slidewire, which eliminates pigtails and their variable inductances. It includes use of a Mumetal slidewire shield where desirable, instead of less expensive but lower-permeability aluminum. And it includes a lot of just downright meticulous detailing, such as carefully engineered wiring and input filtering, plus ingenious shielding where required.

These and other precautions eliminate out-of-phase components in the supply to the amplifier. The latter therefore doesn't "load"; hence sends the correct amount of correct-phase power to the balancing motor. With ample power, the motor's recording and control action is snappy and accurate.

Our Catalog ND46(1) and Technical Publication ND46(1) tell the story. Write our nearest office or 4955 Stenton Avenue, Philadelphia 44, Pa.

Industry's engineers find that Speedomax instrument performance is not affected by the stray fields created by motors, electric furnaces, magnets, power lines and so on.



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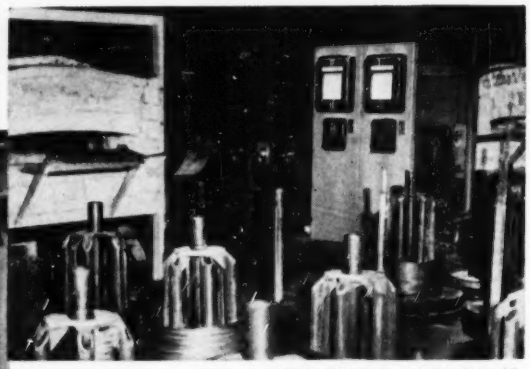

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instruments automatic controls • furnaces

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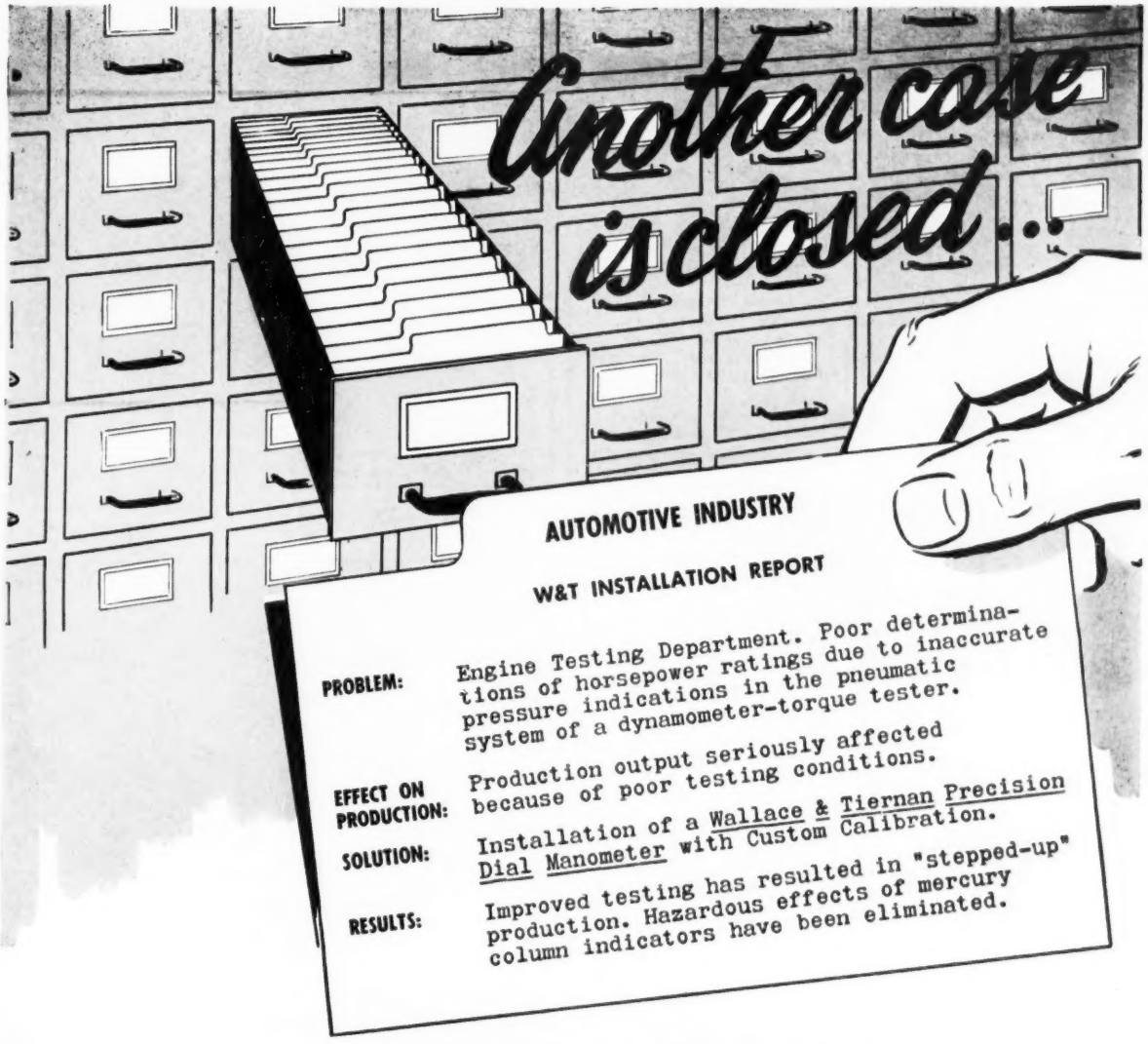

another case is closed...
AUTOMOTIVE INDUSTRY
W&T INSTALLATION REPORT
PROBLEM: Engine Testing Department. Poor determinations of horsepower ratings due to inaccurate pressure indications in the pneumatic system of a dynamometer-torque tester.
EFFECT ON PRODUCTION: Production output seriously affected because of poor testing conditions.
SOLUTION: Installation of a Wallace & Tiernan Precision Dial Manometer with Custom Calibration.
RESULTS: Improved testing has resulted in "stepped-up" production. Hazardous effects of mercury column indicators have been eliminated.

...Thanks to a W&T Precision Instrument

W&T Precision Dial Manometer

FEATURES:

Full protection against overpressure
Custom calibrated scales in units of force or torque
Two revolution indicator provides scale 45 in. long with only an 8½ in. diameter dial.
Sensitivity one part in 10,000; accuracy one part in 1000.
If you have a problem in the measurement or control of pressure, write today for additional information.

WALLACE & TIERNAN
PRODUCTS, INC.
ELECTRICAL MECHANISMS AND PRECISION INSTRUMENTS
Belleville 9, New Jersey • Represented in Principal Cities
In Canada, Wallace & Tiernan Products, Ltd. — Toronto

A-93

TYPE 2007, BASIC UNIT
Contains shock-mounted fork, double triode and all circuitry. Output, 400 or 500 cycles. Accuracy ± 1 part in 50,000. Octal base container, 1½" x 4½". Weight, 10 oz. Power required, 75 to 200 V.-D.C. at 1 to 5 m.a. and 6.3 V. at 300 m.a. Designed for MIL equipment.

TYPE 2003
Same as Type 2007 (at right) except Tube 12AT7 and 5 pigtail components are external.

TYPE 2001-2, BASIC UNIT
Frequencies, 200 to 3000 cycles. Dividers and multipliers available for lower and higher frequencies. Output, 6 V.—JAN construction.

TYPE 2005, UTILITY
Provides 10 Watts at 110 V. Precision frequencies from 50 to 500 cycles. Input power, 50 to 500 cycles, 45 Watts.

TYPE 2121-A, LAB. STANDARD
Outputs, 60 cycles, 0-110 Volts, 10 watts; 120-240 cy. impulses. Input, 50-400 cycles, 45 Watts.

TYPE 2111A, POWER UNIT
50 Watt output. 0-110-220 V. at 60 cycles or any frequency 50 to 1000 cycles.

Precision FREQUENCIES

GUARANTEED ACCURACY
1 PART IN 100,000 (.001%)
except where otherwise noted

The basis of these frequency standards is an electronically actuated high-precision fork, temperature-compensated and hermetically sealed against barometric changes. The partial list of uses at the right not only suggests the broad range of applications but also proven dependability where there can be no compromise with accuracy. Please request details by Type No. Our engineers are available for advice or cooperation on related problems.

WIDELY USED IN SUCH FIELDS AS
Aviation, Navigation
Ordnance, Ballistics
High Speed Photography
Viscosity Measurement
Fluid Flow
Nuclear Physics, Telemetering
Chemical Reaction
Radiation Counting
Computers
Facsimile
Fire Control
School and Indl. Research Labs.
Accurate Speed Control

American Time Products, Inc.

580 Fifth Avenue ***New York 36, N. Y.***

OPERATING UNDER PATENTS OF WESTERN ELECTRIC COMPANY

CHECK THESE 3 WAYS YOU CAN SAVE WITH THIS MULTI-PURPOSE INSTRUMENT

Here is the most sensible idea you've ever seen in a recorder or controller—an instrument you can change as your instrument needs change, that you can add to, subtract from, or whose functions you can increase or decrease at little or no expense.

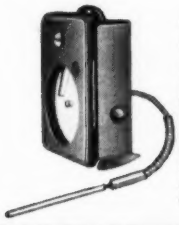
✓ **Save money when you add new functions by adding only those new assemblies needed.**

✓ **Save time-delays by making changes on the job site without returning to factory.**

✓ **Save money on inventory. Parts are interchangeable, fit all Gotham Convertible recorders. You can service a whole group with a minimum stock of basic elements.**

What you can do with the Gotham Convertible

Depending on the chart size of the recorder (6″, 9″ or 12″) you can have a 1-2-3 or 4 pen recorder with 14 pressure, temperature and time operation combinations or a recorder-controller with 38 possible pressure, temperature, and time combinations.



SELF-CONTAINED PORTABLE RECORDER

A portable recorder which has a carrying handle, legs and retaining holder for capillary and bulb. Built from Gotham standard elements, interchangeable with other Gotham instruments. 6", 9" and 12" chart sizes. Mercury, Vapor or Pressure Activated. Spring or electric chart drive. See Catalog 400.

RECORDING PSYCHROMETER

Incorporates the same highly accurate and responsive thermal systems and contains all other Gotham standard convertible features. Wet and dry bulb type. Motor-driven suction fan. 12" chart size. Catalog 400.

RECORDING HYGROMETER

A 2-pen recorder of the wet and dry bulb type. Mercury or Vapor Actuated. 9" and 12" chart sizes. Available with variety of wet and dry bulb assemblies depending on application. Catalog 400.

GOTHAM INSTRUMENTS

Keep everything under control with Gotham

GOTHAM INSTRUMENTS
Division of American Machine and Metals, Inc.
Dept. 2, 233 Broadway
New York 12, New York

Please send me a copy of your

- ☐ Catalog 100—Industrial Thermometers
- ☐ Catalog 200—Dial Type Thermometers
- ☐ Catalog 400—Recorders, Psychrometers, Hygrometers
- ☐ Catalog 500—Controllers
- ☐ Have your representative call. No obligation.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

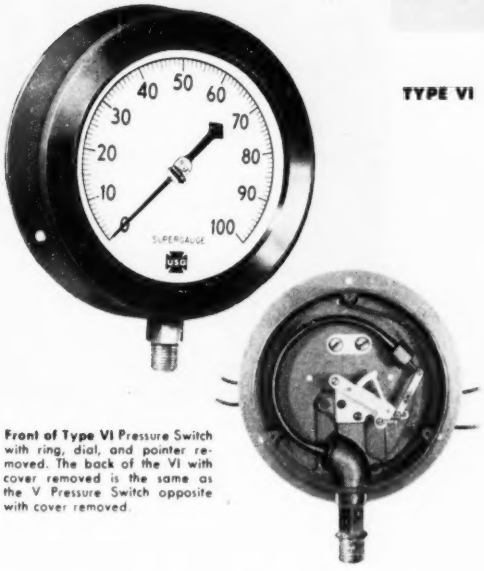
®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

PRESSURE SWITCHES

• What they are • How they work • Where you use them



Front of Type VI Pressure Switch with ring, dial, and pointer removed. The back of the VI with cover removed is the same as the V Pressure Switch opposite with cover removed.

Type V Pressure Switch with cover removed.

The USG Type V Pressure Switch consists essentially of a pair of micro-switches making or breaking contact in response to a pressure-sensitive element (bourdon spring).

Type VI has the same switch-operating pressure element as Type V but it has an additional bourdon spring connected to a pointer so that pressure can be read on a dial.

Pressure switches are used wherever a pressure warning signal must be given. Typical applications are: hydraulic pumps, hydraulic presses, die casting equipment, or guarding or controlling high or low tank pressures.

For information relating to your problem, call the United States Gauge office in your city or get in touch with us at Sellersville, United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

CONSTRUCTION

TYPE V	**Case:**	Cast-iron case, back flange mounting, black crackle finish.
	Size:	4½" case only
	Bourdon Tube:	Beryllium copper or stainless steel
	Pressure Connection:	Lower only: ¼" male N.P.T. up to 1000 lbs. pressure; ½" male N.P.T. for 1000 lbs. and over.
	Electrical Connection:	½" female pipe conduit.
	Pressure Ranges:	Up to 10,000 p.s.i., vacuum to 30".
	Micro-switches:	High and low; rated 10 amps., 110 A.C., both fully adjustable over entire range of gauge.
	Switching Differential:	3%. Switches are not affected by overpressure.
TYPE VI		Same case construction, micro-switches, switch-operating elements, switching differential, pressure connections, electrical connections, and pressure ranges as Type V.
		Case has dividing wall between the separate bourdon springsystems foroperating the pointer and the micro-switches.
	Dial Sizes:	4½" and 6"
	Accuracy of Indications:	½ of 1% of the scale range.

Quality Gauges Engineered for Enduring Accuracy UNITED STATES GAUGE

PRODUCTS OF UNITED STATES GAUGE... Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges • Boiler Gauges Chemical Gauges • Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters • Inspectors' Test Gauges Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges.
OTHER DIVISIONS OF AMERICAN MACHINE AND METALS, INC. AT SELLERSVILLE, PA.: GOTHAM INSTRUMENTS, AND AUTOBAR SYSTEMS

Here's How to Erase Smoke Troubles

VIOLATION OF SMOKE ORDINANCE

LOSS OF FUEL ECONOMY

BAD COMMUNITY RELATIONS

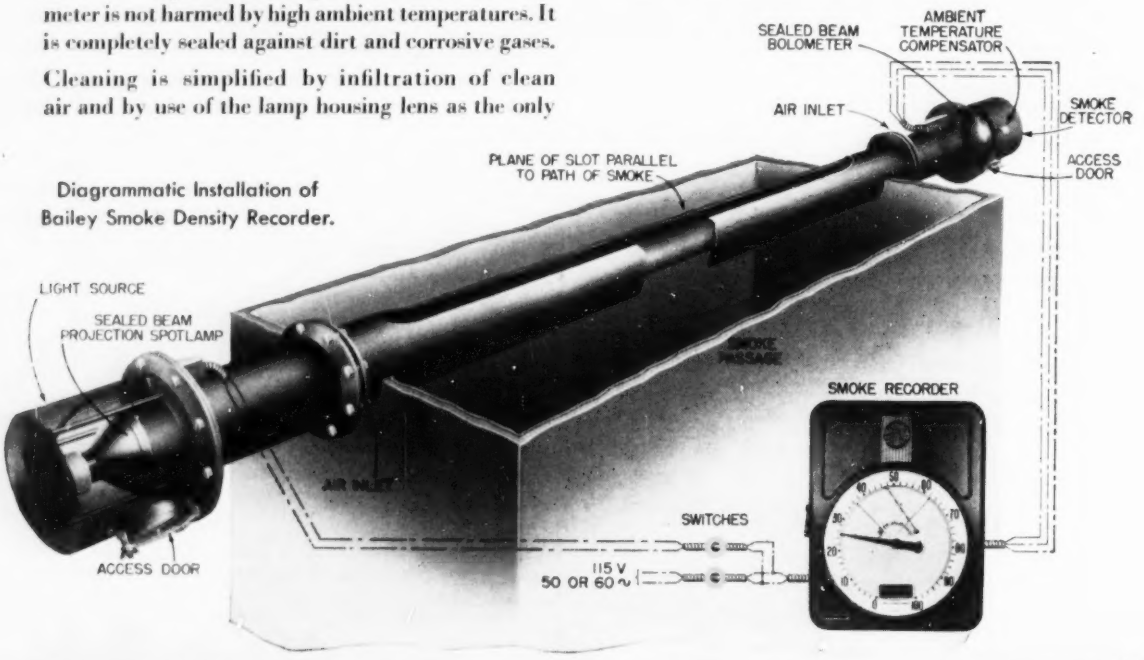
★ One of your first steps in erasing these troubles which result from excessive smoke, should be the installation of a Bailey Smoke Density Recorder. This 24-hour recorder is not an ordinary photo-cell instrument. Instead it detects smoke density by a Bolometer which is simply a sturdy tungsten filament and a parabolic mirror, mounted in a standard sealed beam automobile head lamp housing.

In using this simple, unique smoke detector, you do not have to provide cooling devices since the Bolometer is not harmed by high ambient temperatures. It is completely sealed against dirt and corrosive gases.

Cleaning is simplified by infiltration of clean air and by use of the lamp housing lens as the only window between the Bolometer and the gas passage.

It's easy to secure and maintain alignment of the sealed beam light source with the Bolometer since they are mounted at opposite ends of a slotted pipe which extends across the smoke passage.

For complete information on how you can profitably use this unique instrument to erase your smoke troubles, ask for Bulletin 211, "Bailey Smoke Density Recorder".



Diagrammatic Installation of Bailey Smoke Density Recorder.

G-29

BAILEY METER COMPANY

1041 IVANHOE ROAD, CLEVELAND 10, OHIO • BRANCH OFFICES IN PRINCIPAL CITIES

BAILEY METER COMPANY LIMITED, MONTREAL, CANADA

Let Bailey Smoke Density Recorders Watch Your Stacks

ALL RANGES WITH THIS ONE CONTROL

Model 630

Just *one* knob—extra large—easy to turn—flush with the panel, controls all ranges. This one knob saves your time—minimizes the chances of "burn-outs" because you don't have to remember to set another control. You can work fast with Model 630 with your eyes as well as your hands. Look at that scale—wide open—easy to read, accurately. Yes, this is a *smooth TV* tester. Fast, safe, no projecting knobs, or jacks, or meter case. Get your hand on that single control and you'll see why thousands of "Model 630's" are already in use in almost every kind of electrical testing

ONLY $39.50 AT YOUR DISTRIBUTOR

In Canada: Triplett Instruments of Canada, Georgetown, Ontario

FOR THE MAN WHO TAKES PRIDE IN HIS WORK

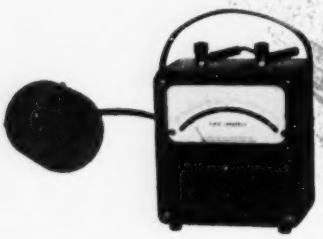
Triplett

TRIPLETT ELECTRICAL INSTRUMENT COMPANY · BLUFFTON, OHIO, U.S.A.

instruments for measuring light

Model 703
Sightmeter or
Foot-Candle Meter

The favorite for quick measurements in homes, offices, factories, schools, etc. Calibrated in seeing tasks (Sightmeter) and directly in foot-candles. Available with or without VISCOR® and cosine correction filters. Special Model 703 for use as a Screen Illumination Meter.



Model 931 Foot-Lambert Meter

A versatile instrument for the direct measurement of brightness. It also meets the requirements as outlined by the Phosphor Committee of the RMA for television tube brightness measurements. A VISCOR® filtered high output cell is used in conjunction with a very sensitive microammeter. The cell is equipped with a tubular baffle which restricts the oblique light and provides a basic range of 0-60 foot-Lamberts. A removable multiplier disc provides a second range of 0-300 foot-Lamberts.

Completely self-contained, permanently calibrated, and color corrected, Weston Light Measuring Instruments are available for practically all requirements in research, factory, office or home. A bulletin giving complete details on all models and on color and cosine correction features is available on request. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

Model 614 Foot-Candle Meter

Ideal for commercial lighting surveys and general light measurements. Hinge mounted PHOTRONIC® Cell can be tilted to facilitate use. Measures all types of commercial lighting directly. Wide range of light values, with convenient range-changing switch. Self-contained in sturdy Bakelite case with handle.

Model 756 Illumination Meter

For light measurements requiring a high degree of accuracy over broad ranges. Ideal for research work and for checking other instruments. Corrected for color and Lambert's Cosine Law ... long mirror scale and knife edge pointer...convenient range changing switch... furnished in sturdy leather carrying case with neck strap.

WESTON
LIGHT MEASURING *Instruments*

The Superior Tube That Keeps Cool in a Hot Spot

Cooling off customers' hot problems is a Superior specialty.

An example is illustrated above. The customer, Fenwal, Incorporated of Ashland, Massachusetts, manufactures THERMOSWITCH® industrial thermostats; Aircraft temperature controls, fire and overheat detectors; DETECT-A-FIRE® fire detectors. All of these products use stainless steel tubing. Before consulting with us an extra machining operation on the inside diameter was required. The tubing used needed a special temper for softness.

Problems like this one are tailor made for Superior. We produced for Fenwal a tube with a smooth, clean, almost mirror-like inside finish to eliminate the need for the extra machining operation. We were able to do this while still maintaining the low physicals necessitated by a stress cracking possibility.

What's more, the finished product was not a "specialty" tube. Our long experience in fine small tubing, backed by highly developed production equipment and extensive research and testing facilities enables us to produce tubing to the strictest specifications in large quantities. If you have a production problem involving the use of top-quality small tubing to do tough jobs well, check with us. We can probably supply you from the stocks of our distributors who are located in principal cities. Write for Catalog #20, Superior Tube Company, 1968 Germantown Ave., Norristown, Pennsylvania.

BE SURE ABOUT TUBING— SPECIFY

Superior

THE BIG NAME IN SMALL TUBING

All analyses .010" to ⅜" O. D.
Certain analyses (.035" Max. wall) up to 1⅜" O.D.

ROUND AND SHAPED TUBING

Available in:

Carbon Steels:
A.I.S.I.—C-1008, MT-1010, MT-1015, C-1118, MT-1020, C-1025, C-1035, E-1095.

Alloy Steels:
A.I.S.I.—4130, 4132, 4140, 4150, 8630, E-52100.

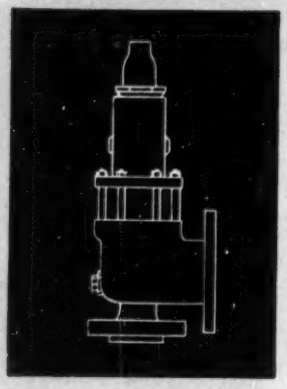
Stainless Steels:
A.I.S.I.—303, 304, 305, 309, 310, 316, 317, 321, 347, 403, 410, 420, 430, 446, T-5.

Nickel Alloys:
Nickel, "D Nickel"*, "L Nickel"*, "Monel"*, "K Monel"*, "Inconel"*, 30% Cupro Nickel.

Beryllium Copper

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. UNderhill 0-1331.

*Reg. U. S. Trademark International Nickel Company



SAFEGUARDED AGAINST CORROSION...

Bellows Sealed

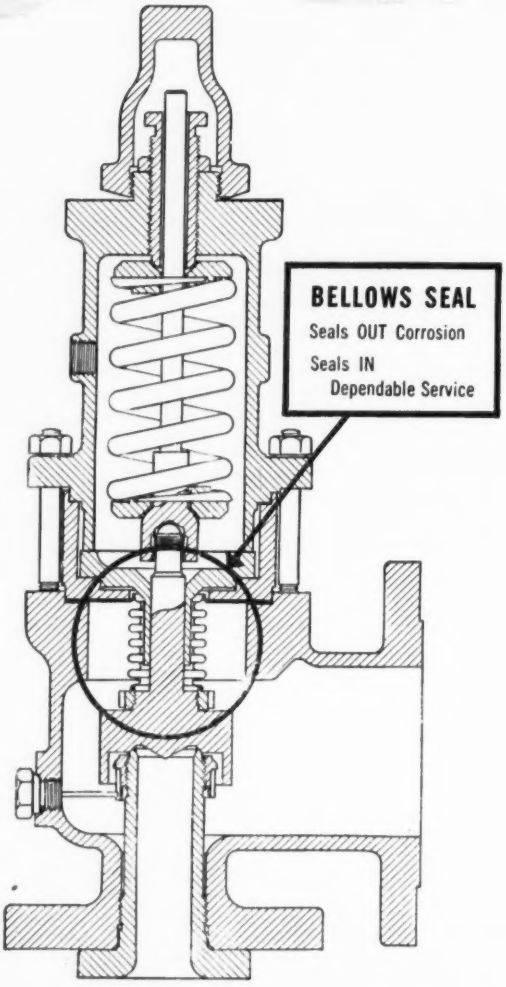
CONSOLIDATED SAFETY RELIEF VALVES

CORROSIVE LIQUIDS OR GASES cannot attack the spring and guiding surfaces between the disc guide and disc in these Consolidated Safety Relief Valves. The BELLOWS SEAL encloses them in an armor of stainless steel — protects these vital parts against corrosion — assures continuous, dependable valve operation. Because the bellows is long and soft, you can be certain of optimum performance of the valve in service.

AISI TYPE 316 STAINLESS STEEL is used in the standard bellows of these valves. If the corrosion-resistance of another material is better suited to your process, and a bellows can be fabricated from it, we will let you know the cost of valves of such construction upon request.

VARIABLE BACK PRESSURE SERVICE is permissible for Bellows Sealed valves, provided gauge back pressure variations do not exceed 15% of the gauge set pressure. In such applications, the set pressure and blowdown are constant, within practical limits, when the valve is subjected to variations in downstream pressure.

BELLOWS SEALED Consolidated Safety Relief Valves have every other superior design and construction feature to assure continuous, economical performance at their rated capacities. Get all the facts about their quality and "safety-first" dependability.



CONSOLIDATED SAFETY RELIEF VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** TULSA, OKLAHOMA

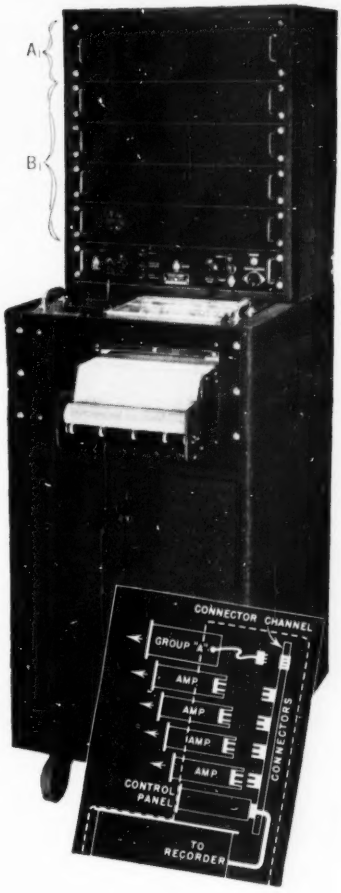
MAKERS OF 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

It's VERSATILITY that sells SANBORN in the field of Industrial Recording

As indicated by references at the right, you may have a choice of five different instruments (A) for quick and convenient standard rack mounting in the system at A_1, PLUS a choice of up to four of any of the three different type amplifiers (B) or any combination of these amplifiers

with the

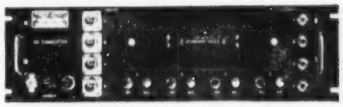
SANBORN
FOUR-CHANNEL
OSCILLOGRAPH RECORDING SYSTEM
(MODEL 67)



A

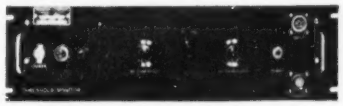
DC PREAMPLIFIER

AC PREAMPLIFIER



DC CONVERTER—for low level DC recording such as thermocouple output.

TRIPLEXER—when coupled to a DC amplifier permits the recording of three events in one channel.



THRESHOLD MONITOR provides means for the control of voltage levels or rate of change.

B

DC (General Purpose) AMPLIFIER

STRAIN GAGE (Carrier) AMPLIFIER

SERVO MONITOR AMPLIFIER—a phase discriminating AC amplifier used in servo design and testing.

As shown in the diagram, removing or interchanging any of the amplifiers or other instruments is simply a matter of sliding the unit in or out of the mounting rack where contact is made automatically by plug-in connectors. Screws at the four corners of the panel hold the instrument in place.

Other features of this system which add to Sanborn VERSATILITY are the choice of eight paper speeds—50, 25, 10, 5, 2.5, 1.0, 0.5 and 0.25 mm/sec, and the use of either 4-, 2-, or 1-channel recording paper.

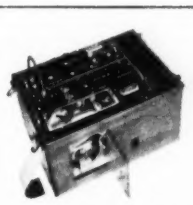
And, of course there are these popular Sanborn advantages: a high torque movement (200,000 dyne cms per cm deflection), direct *inkless* recording in *true rectangular coordinates*, and provision for code and time markings.

Sanborn Recording Systems may be used to record any one or more of a wide variety of phenomena whose characteristics range from static to 100 cycles per second. If your recording problem is not one which can be solved by standard Sanborn equipment, our engineers will be glad to suggest ways in which modifications of it may suit your requirements.

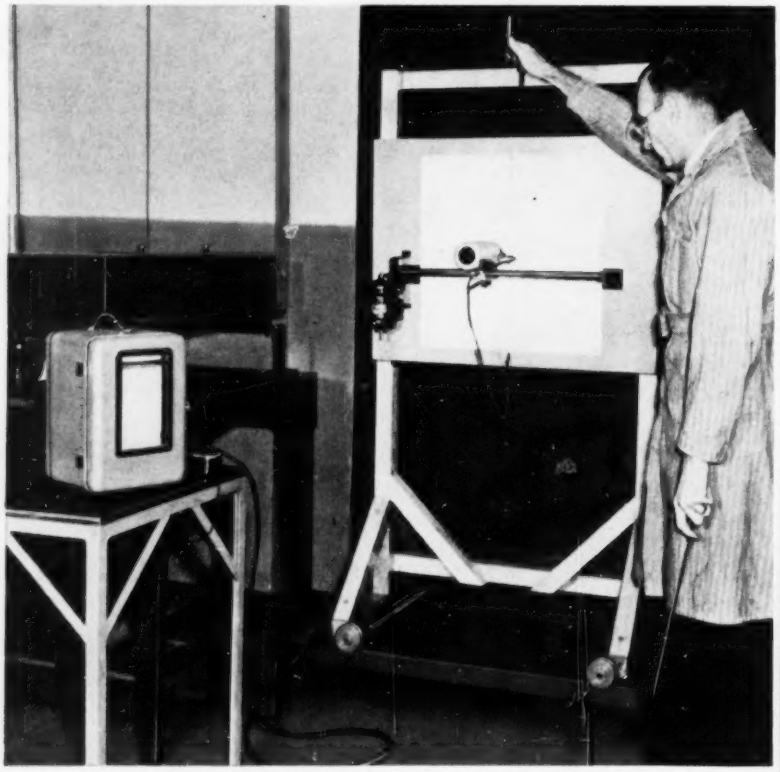
A complete catalog of Sanborn Industrial Recording Equipment will be sent gladly on your request.

SANBORN COMPANY
CAMBRIDGE 39, MASS.

SANBORN 1-, AND 2-CHANNEL RECORDING SYSTEMS



One channel Model 128/141 above and two-channel Model 60 at right both incorporate Sanborn recording advantages which include interchangeability of amplifiers and (with Model 60) preamplifiers.



RECORDER PROVIDES LABORATORY WITH RECORD OF LIGHT INTENSITY OF CARBON UNDER TEST

ClevelandResearchLaboratoryUses G-E Recorder for Arc Light Studies

The Cleveland Research Laboratory of the National Carbon Company gives General Electric's photoelectric recorder an important place in its test set-ups for positive carbon craters used in carbon arc lamps. This fast-response recorder furnishes an accurate record of the light intensity of the carbon under test.

PORTABLE, VERSATILE

Because it combines the convenience of portability with a sensitivity and versatility far beyond the range of ordinary recording instruments, the recorder is ideal for many research programs.

HIGH SPEED RESPONSE

Besides measuring a-c and d-c volts and amperes, it will record almost anything that can be measured with an indicating instrument. Chart speeds range from ½ inch to 72 inches per minute; sensitivities are as great as 1.0 microamperes full scale; response periods are as fast as 1.5 second for full-scale deflection.

Contact your G-E representative for details or check the coupon on the next page for publication GEC-254. Prices for the portable recorder start at $698.88.*

Thermocouple Potentiometer Aids Checks of Jet-Engine Performance and Controls

At the U.S. Air Force's Edwards Base, Muroc, California, a Type PJ-1 thermocouple potentiometer is being used to aid performance checks of the G-E J-47 jet engines in the F-86D Sabrejet, and the B-47B, Stratojet.

In addition to this application, the thermo potentiometer can be used in the laboratory to check temperatures for heat-runs on motors; or refrigerator development work; oil-burner and air-conditioner tests; and oven and furnace temperature surveys.

WIDE VARIETY OF RANGES

The PJ-1 has three millivolt ranges, 0-6, 0-30, and 0-60 mv. A variety of

temperature scales can be supplied for measurement from below zero to 2500 F. Because temperatures can be read directly in degrees F or C, the PJ-1 can be easily used by untrained personnel.

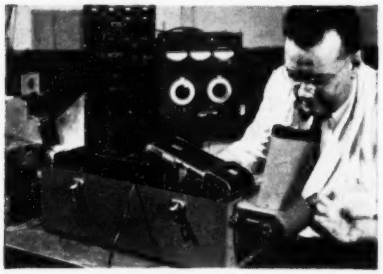
HIGHLY ACCURATE

Accuracy of the PJ-1 is ±.2% of full scale. Price is $198.90* in standard 0-6 millivolt ranges. A portable 10-point transfer switch is also available. Publication GEC-245.

GENERAL ELECTRIC

FOR PRECISION MEASUREMENT

Three Accessories Make G-E Low-Cost Portable Oscillograph More Versatile



Three new accessories for the G-E Type PM-18 portable oscillograph increase its versatility for industrials which require a low-cost instrument that will record two, three, or four rapidly or slowly changing currents and voltages simultaneously.

CONTINUOUS-DRIVE FILM HOLDER

The new accessories include a continuous-drive film holder for applications which require an extra long record; and a new high-sensitivity galvanometer with a rating of 1.67 millimeters per microampere at one meter.

NEW SWEEP MIRROR

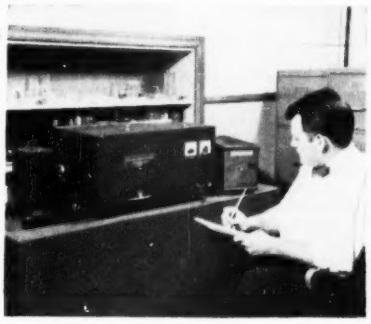
A newly incorporated sweep mirror provides adjustable time sweep of 0.1 to 0.5 second in addition to the original non-adjustable 1/60-second sweep.

The PM-18 with Polaroid-Land film holder and 2 galvanometers costs only $773.76.* Check coupon for bulletin.

Phoenix Precision Instrument Co. Recommends G-E Galvanometer for Use with Photometer

"We prefer the G-E galvanometer because of its simplicity of zero adjustment. Furthermore, it has the short-time response period needed for use with our photometer. Because of these features, we recommend its use in conjunction with the Phoenix B-S light-scattering photometer," reports Mr. Edward J. Fuhrmeister, co-owner of the Phoenix Precision Instrument Co., Philadelphia, Pa.

Many industrial laboratories, universities, and government agencies are using this instrument combination to measure the molecular weight of high polymers, protons, and other molecules. The instruments can also be used to measure absolute turbidity, depolarization, and dissymmetry of scattering.

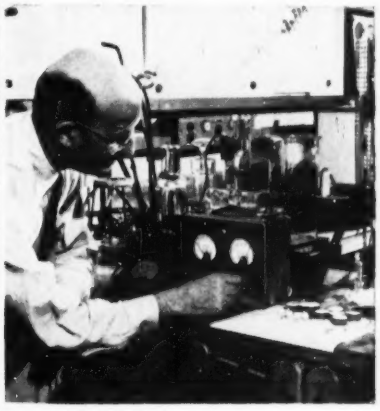


Designed to measure low values of current or voltage, General Electric portable galvanometers are supplied in forty-eight different ratings; all use a light-beam mechanism. Strong alnico magnets permit compact design. Suspension elements may be interchanged to suit job requirements. The galvanometers are self-contained—no separate lamp stand or scale is necessary.

Publication GEC-694. Price of high-sensitivity, portable type, $102.96.*

G-E MEASURING EQUIPMENT CATALOG

80 pages describing all of General Electric's testing and measuring devices. For free copy check GEC-1016 in coupon at right.



G-E Thermocouple Vacuum Gage Aids Metal Evaporation Process

The General Electric Research Laboratory currently uses over 200 G-E thermocouple vacuum gages. Typical of the many applications for which these gages are used is the one shown above. Dr. L. R. Koller, scientist at the laboratory, is pictured working on a process which evaporates metal coatings onto insulating surfaces.

Dr. Koller says, "I find this G-E gage entirely satisfactory for this operation. It can be installed in the vacuum system easily and gives continuous vacuum readings."

The G-E thermocouple vacuum gage provides a convenient means of measuring pressures from 1 to 500 microns. It can be supplied for either glass or metal vacuum systems and is available in either a-c or battery-operated types. Price is $117.58*. Check coupon below for GEC-385.

Manufacturer's suggested retail price

SECTION A605-30, GENERAL ELECTRIC CO.
SCHENECTADY 5, N. Y.

Please send me the following bulletins.
Indicate:
√ for reference only
× for planning an immediate project

- ☐ Photoelectric Recorder (GEC-254)
- ☐ Thermocouple Potentiometer (GEC-245)
- ☐ Type PM-18 Oscillograph (GEC-580)
- ☐ Portable Galvanometer (GEC-694)
- ☐ Thermocouple Vacuum Gage (GEC-385)
- ☐ Measuring Equipment Catalog (GEC-1016)

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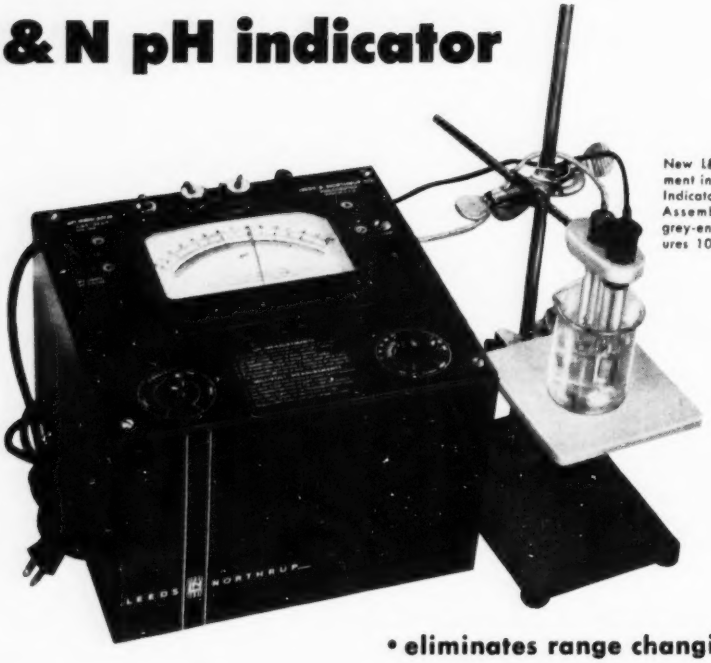
stabilized

L&N pH indicator



New L&N pH Indicator. Equipment includes: line-operated pH Indicator and Electrode Holder Assembly. Indicator case, of grey-enameled aluminum, measures 10½" x 10¼" x 8⅛".

• eliminates range changing

• readable to within ±0.02 pH

This *converter-type* pH Indicator offers remarkable stability. Embodying important refinements in circuit design, it is unaffected by normal fluctuations in line voltage . . . or by zero drift of the amplifier.

In lab or plant—you'll appreciate the many advantages of this new instrument. The few required adjustments are simple to make. Single, *continuous* pH 0 to 14 scale eliminates range changing . . . a big help when you're working near pH 7. And you can read to within ±0.02 pH . . . on either grounded or ungrounded solutions.

Key to stability: the Indicator incorporates the high quality shielded *converter* developed for our Speedomax electronic recorders. Its circuit employs d.c. to a.c. conversion, a.c. amplification, and conversion back to d.c. for voltage feedback. Conversion stabilizes zero. Feedback stabilizes gain.

For details—send for Folder EM9-96(1). Write 4955, Stenton Ave., Phila. 44, Pa.

Check these distinctive L&N advantages...

- √ **Continuous 5⅓" scale**—covers full range of pH 0 to 14 . . . readable to ±0.02 pH.
- √ **Electrode system**—takes any suitable type . . . but circuit especially designed for high resistance glass electrode systems.
- √ **Grounded or ungrounded solutions**—can be checked with equal ease and accuracy.
- √ **Only 2 controls, 1 switch**—standardization and temperature-millivolt controls . . . zero switch.
- √ **4 voltage ranges**—0 to +700, 0 to −700, 0 to +1400, and 0 to −1400 mv . . . for redox work and Karl Fischer Titration measurements.
- √ **Fast warmup**—not more than 1 minute.
- √ **Short response time**—1.5 seconds . . . for most readings.

LEEDS NORTHRUP

Ind Ad EM9-96(2)

Editorial Comment

Bandwagon?

THERE is a rush to get on the instrument bandwagon. Many educators and research workers, particularly, are waking to the fact that the new field of instrumentation has matured under their noses, while their attention was elsewhere. Despite the fact that many individuals and organizations (like the magazine *Instruments*) have been trying for twenty-five years to obtain their help and cooperation in developing the field, these men first ignored the field and then asserted that it was a minor part of their own particular field of endeavor. Finally, now that it is no longer possible either to ignore it or to treat it as a junior partner, they are claiming it as a "brand-new" field recently discovered by themselves.

We who have worked so long and diligently to raise the child do not resent the sudden influx of attention; this is what we worked for; this is what we want. But we must ask the newcomers not to ignore all that happened in the years preceding their recent awakening.

For example, there happens to be a fairly standard terminology in the field, a terminology that has been used for several decades by the thousands of men who have worked in the field for those decades. The term "Instrumentation" is accepted for the science of measurement and control.

However, we are now witnessing attempts by many to call the automatic-control branch of the science of Instrumentation the science of "automation," or "cybernetics," or even the science of "feedback." The coining of names may be an easy way for a man to make a mark in a field, but it can injure the field. Feedback is the simple technique of feeding a part of the output of any device back into its input; it is not a science. A closed-loop null-seeking servomechanism is a basic system, not peculiar to any single field. Its mathematics and principles are the same as those in any other null-seeking closed-loop system, including radar-antenna positioning systems, rolling-mill drive control, human control of a finger, automatic-pilot control of an airplane, or servocontrol of a milling machine. There is no need to call one cybernetics, another automation, and still others by other names. To do so confuses and obscures the essential simplicity of these physical systems and their place in the general scheme of things.

We welcome all newcomers to our OLD field of instrumentation. We welcome their thoughts and work. But they perform no service by coining new words for the well-known, well-understood, commonly used and simple terminology now in use in the field. Instrumentation, the science of MEASUREMENT and CONTROL, has limitless opportunities and unexplored boundaries. There is much real work to be done.

Reflections on Reflections

These are some thoughts on the "review-and-forecast statements" that were published in our 25th Anniversary issue last month. Of interest is the fact that so many of the distinguished authorities considered the fields of process control via product analysis and electronic computing as being on the threshold of a new era. Industry today is aware of the tremendous implications of these two "new" developments. Their use is being investigated actively in dozens of different ways and industries. Although we do not anticipate early replacement of existing "boards of directors" by analyzers and computers (as one author hinted) the boards of directors will of necessity become instrument-minded. They will have no alternative when the instrument costs of a plant become a major part of the plant investment.

Of interest also is the great expansion of instrument use in chemical and biological research. Research executives have at long last learned that expenditures for instruments are of that desirable type—the kind that return much more than the investment.

A third point brought out by the prognosticators is how rapidly the newest developments in research are investigated and used in instruments that make possible still more developments. The boundaries are never in sight.

Education

A recent development (not unallied to the recent recognition of the essential importance of instrumentation) is the great interest in education of technical workers and students in instrumentation. The day is not far off when a course in Process Measurements and Control Equipment is a requirement for all chemistry students, and a course in Indicating, Recording, and Control Instruments is required of all technical students. We wish to emphasize that we are bringing a lot of material on this subject to our readers. In the last few months we published: "Steel Plant Training and Maintenance Facilities" (Dec. 1952) and "On-the-Job Training" (Sept. 1952). In this issue is Part II of the Serial "Automatic Control of Chemical Processes"; next month we present the article "A University-level Course in Process Instrumentation."

Our Expanding Field

"U. S. industry can increase its profits by increasing its use of specialized measuring instruments," G. Howard Black, general manager of the General Electric Company's Meter and Instrument Department, said in Lynn, Mass. recently. Speaking to 90 G-E measurement specialists and district sales executives at the opening of a four-day Meter and Instrument Specialists' Conference he advised the conference, "Look for locations where manufacturers are experiencing production difficulties, and you will find many applications for specialized measuring instruments."

At the same conference, John G. Garrett, acting manager of marketing for the General Electric Company's Meter and Instrument Department, told the specialists that "with each new technical development in the world today, there is a corresponding increase in the demand for electric measuring devices."

"We expect demand for electrical measuring devices nearly to double within the next decade as new developments increase," he said, explaining that this forecast was based upon statistical analysis and conservative estimates of business trends.

The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 313

Density-gage System for Industrial Measurements

New "Bulletin 10425 Ohmart Density Gauges" offer a new direct method of measuring process variables where density is a function of desired measurement. New system employs penetration power of radioactivity to make possible measurements heretofore considered impractical or impossible because of high temperatures or pressures, or corrosive or erosive elements. Among variables that can be measured by this new null system of measurement are liquid level and interface liquid level, surface films, specific gravity, unit weight per unit area, gas or liquid composition. Many installations can be made without need of connections to process piping or vessels. Basis for the new "Density Gauge" is "Ohmart Cell" in which radioactive energy is converted directly into electrical energy.—*The Ohmart Corporation, 2347 Ferguson Road, Cincinnati 38, Ohio.*

Mention No. 201 when filling out card.

Industrial Flowmeter

New "Flo-Watch Model AFUAQ" for metering flow of liquids, steam, air and gas through standard differential producers such as Venturi tubes, nozzles,

and orifices, is adaptable for any combination of totalizing, indicating or recording functions. A totalizing model with transmitter attachment can actuate a secondary instrument or pace a chemical feeder remotely located. A Summation Meter also may be operated from transmitting attachments in several individual "Flo-Watch" instruments. Totalizer reads directly in quantity units.—*Builders-Providence, Inc., 345 Harris Ave., Providence, R. I.*

Mention No. 202 when filling out card.

Central Production-control Computer and Indicator

New "OSP Computer," said to be the only instrument of its type, continuously indicates deviations from established production schedule. Indication is quantitative: number of pre-set "production deviation units." Instrument thus does away with slowness, inconvenience, cost (and possible irritation and inaccuracy) of gathering and compiling production-schedule information by human agencies. Left half of dial has red "behind-schedule" scale; right half has green "ahead-of-schedule" scale; midpoint represents "exactly on schedule." Red, amber, white and green lights,

190A

and a buzzer, supplement dial. Principle: continuous comparison of signals emitted at a pre-set rate against signals representing actual rate; and continuous indication of difference. For fast production, "unit multiplier" may be set at 10, 15 or 25 instead of unity, and time-setting also adjusted. Installation is simple, requiring only a pair of wires between computer and a contacting (or photoelectric) device providing an electrical impulse of 0.05-second minimum duration each time a unit comes off production line.—*Industrial Computer Corp., 272 Lembeck Ave., Jersey City 5, N. J.*

Mention No. 203 when filling out card.

Central Quality-control Computing System

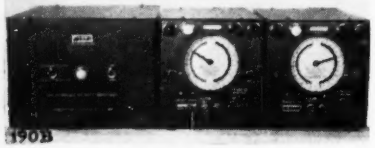
New "OSR Computer" continuously computes and indicates quality-level of production. It is a system consisting of one "master unit" (at left in photo) and any number of "reject analyzers" (similar to "OSP" described in preceding new-instrument report). Master unit emits a series of signals representing anticipated rejects on either a percentage or a probability-curve basis. When required, it can operate on both bases simultaneously. Each reject analyzer receives two series of signals: from master and from an inspection station. Master continuously solves either (or both) of the two equations lettered in illustration, where R_I is deviation reject units indicated on reject-analyzer dial, R_A is actual num-

Straight Percentage Basis:

$$R_I = R_A - (P \times N)$$

Probability-curve Basis:

$$R_I = R_A - \left[\left(P + 3\sqrt{\frac{P(1-P)}{N-1}}\right) \times N\right]$$



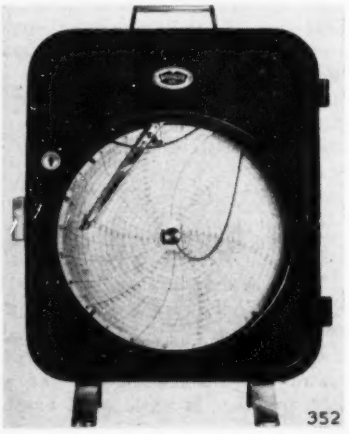
190B

ber of rejects, P is average fraction rejects expected and N is total units inspected; and feeds results to reject analyzer. Each reject analyzer continuously indicates difference. Any specified reject probability curve, other than generally-accepted one, can be incorporated. Percentage-selector range of 0-to-1 percent and 0-to-10 percent combined in one unit.—*Industrial Computer Corp., 272 Lembeck Ave., Jersey City 5, N. J.*

Mention No. 204 when filling out card.

Recording Thermometers

New line of recording thermometers can be furnished in 8-in., 10-in. and 12-in. chart sizes, for wall or flush mounting, or portable use, and for single-pen or double-pen recording. Cast aluminum case is rust-, dust-, fume- and moisture-proof. Stainless steel movement has a micrometer adjustment. Hand wound or electric chart



352

AMPHENOL

from Research, through Design, Development and Production...

. . . all working together as a unified team . . . that's Amphenol!

Every one of the over 9,000 electronic components in the Amphenol line has been tested and twisted, frozen and baked and in some instances simply "shocked" to death. This testing and checking occurs not only in preliminary design and development stages, actual production samples are also "tortured" in order that Amphenol engineers may know the complete strength and weakness of each design, finish and material.

One of the principle strengths of the Amphenol team is the vast accumulation of engineering experience and ability at Amphenol. Amphenol's customers recognize this fact and bring their application problems to Amphenol. As a result, over 75% of the Amphenol line has been developed to meet specific needs in the electronic industry.

Rigid quality controls have been set up to assure the equipment manufacturers that each Amphenol component will perform as specified.

The exacting nature of equipments requiring quality electronic components, as well as the continued growth in the number of manufacturers who specify Amphenol, has developed a highly specialized, highly productive, multi-plant operation.

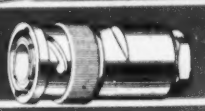
The net result of this finely coordinated team of specialists, working with the most modern equipment in production-engineered buildings, provides a higher level of consistent quality with greater achievement in delivered efficiency.

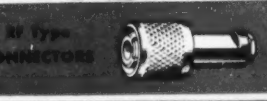
Electronic Components by AMPHENOL

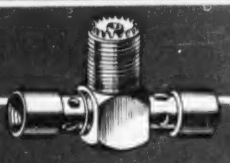
Consult Amphenol for your connector and cable requirements in radio and power circuits. Over 9,000 items are available in the general categories listed below, plus application and development engineering consultation, at Amphenol.

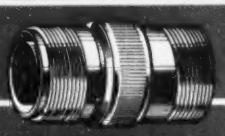
RACK and PANEL Type CONNECTORS
AN Type CONNECTORS
RF Type CONNECTORS
AUDIO CONNECTORS
POWER PLUGS
BLUE RIBBON CONNECTORS
INDUSTRIAL SOCKETS
MINIATURE SOCKETS
TUBE SOCKETS and RADIO COMPONENTS
MICROPHONE CONNECTORS
RG COAXIAL CABLES, TEFLON and POLYETHYLENE
CABLE and WIRE ASSEMBLIES
PLASTICS — EXTRUDED and INJECTION MOLDED

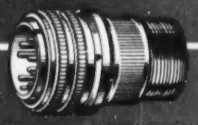
***Write* Department 13H for your copy of General Catalog B-2**

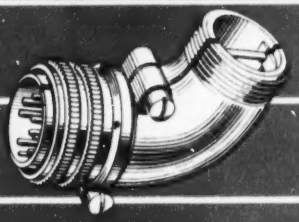


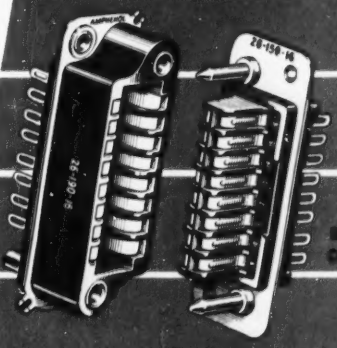


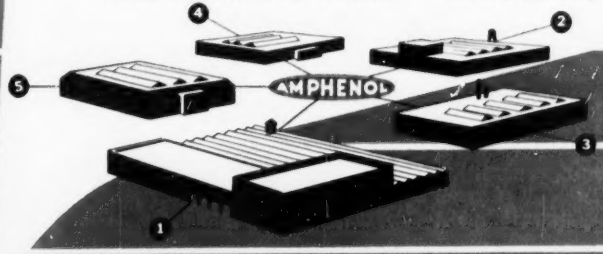


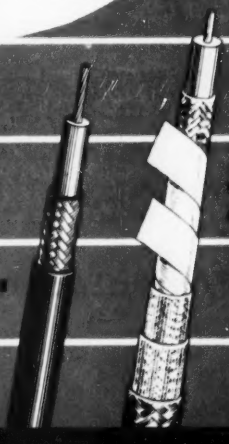












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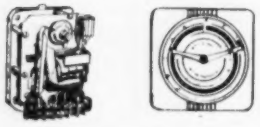
LABOR COST IS UP

Problem:
MATERIAL COST IS UP

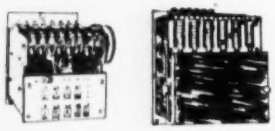
Problem:
SELLING PRICES REMAIN

ANSWER

Your machines plus precision timers made by Eagle.



Eagle "know how" engineers, (without obligation), will study your individual process and suggest the right timer to improve the quality and speed-up production of your product. You can save countless man-hours for greater profit with Eagle automatic timing or counting.



A TIMER FOR EVERY TIMING PROBLEM

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Industrial Timers
EAGLE SIGNAL CORPORATION MOLINE, ILL.

SEND FOR GENERAL BULLETIN 340

NEW INSTRUMENTS

drives for 12- or 24-hour or 7-day revolution. (Other periods can be furnished.) Stainless steel interlocked spiral armor over stainless steel capillary tubing, reinforced at bulb and case. Plain bulb, union connection, or separable socket assembly.—*Weksler Thermometer Corp.*, 49 *W. 32nd St., New York* 1, *N. Y.*

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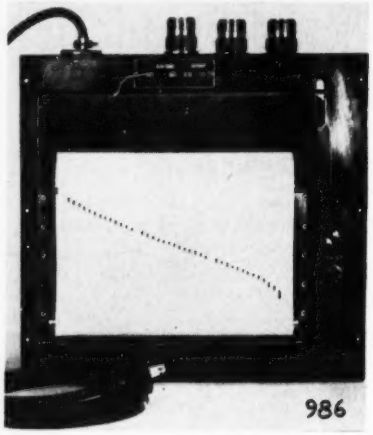
Multi-stylus Recorders

New "Series RX-30" multi-fixed-stylus recorders permit obtaining a large number of simultaneous records across a 9½-in. wide chart. Recording

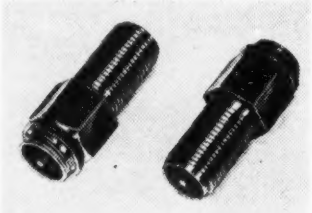


medium is "Faxpaper," a current-sensitive electrolytic recording paper with wide-range half-tone characteristics for gathering additional information in each marking channel by means of variable-density recording techniques. New recorder is supplied in a choice of fixed chart-advance speeds; number of styluses may also be varied to meet requirements. Illustrated is "RX-30C" which has 39 styluses and a chart speed of 4 in. per second. A 400-foot roll of "Faxpaper" will feed this recorder for 20 minutes.—*Hogan Laboratories, Inc.*, 155 *Perry Street, New York* 14, *N. Y.*

Mention No. 206 when filling out card.

Contactless Impulse Generator

New "Model 3010" magnetic pickup is for measuring rate of motion at all speeds without physical contact or "drag" when mounted near any moving magnetic material. It produces a voltage output proportional to rate of motion or speed of magnetic object. It may be actuated by a shaft keyway, gear teeth, wheel spokes, a screw head or pin on a moving part, or any vibration or displacement of magnetic material in its field. It actuates electrical



counters; serves as tachometer when used with voltmeter; controls electrical devices when used with amplifiers and relays; provides synchronizing voltage for oscillograph; markers for angular or linear position in measuring displacement. Resonant frequency 60,000 cps. D-c. resistance 145 ohms; impedance, 500 ohms at 1000 cps.—*Electro Products Labs., Inc.* 4501 *N. Ravenswood Ave., Chicago* 40, *Ill.*

Mention No. 207 when filling out card.

Unbreakable Manometer

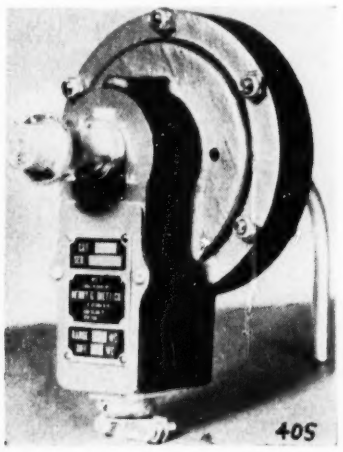
New "Series No. 1211 Flexible Slack-Tube Manometer" comprises a convexed spring-steel scale and a vinyl

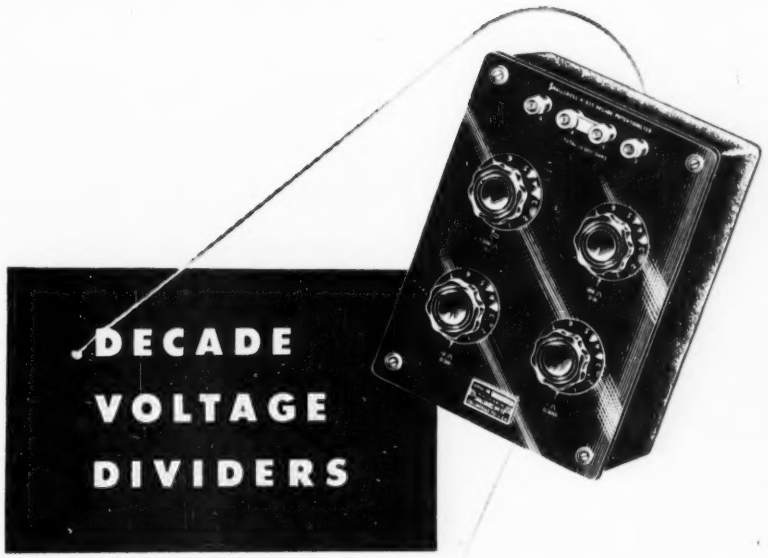
plastic body. It rolls up to fit into pocket or kit, returns to a full-length, easily-read U tube. Scale is firmly held, yet may be moved back and forth for zero adjustment. Instrument is available in standard ranges from 8 inches to 10 feet water or mercury.—*F. W. Dwyer Mfg. Co.*, 317 *S. Western Ave., Chicago* 12, *Ill.*

Mention No. 208 when filling out card.

Pressure Controller

New "Cat. 101P Sensitive Static Pressure Control" is an improved version of "Cat. 101" employing a silicone-impregnated glass cloth diaphragm said to allow operation at high or low temperatures over long periods of





ACCURACY, STABILITY,

RUGGEDNESS . . . AT MODEST COST

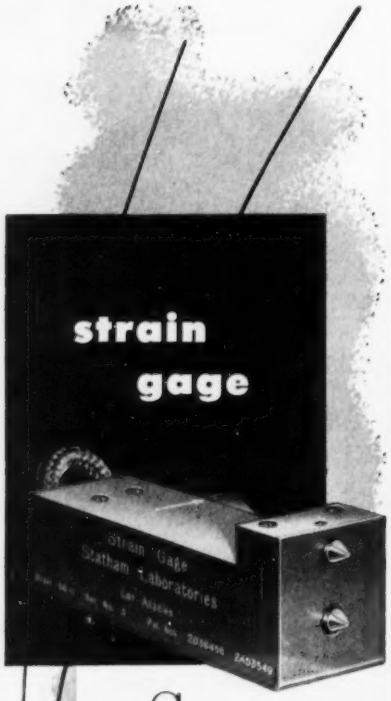
Dependable accuracy . . . year in, year out . . . for delicate laboratory measurements or rugged production line tests—that's the record of Shallcross Decade Voltage Dividers.

These handy instruments use the same high stability Shallcross precision wire-wound resistors that have been familiar to designers and users of electric-electronic equipment for over 20 years.

Models are available in resistance ranges to suit virtually every requirement calling for voltage division with constant input resistance. Basic types are listed below. Special tolerances and other ranges are available on special order. For complete engineering details, write for Bulletin L-16A. SHALLCROSS MANUFACTURING CO., Pusey & Lincoln Aves., Collingdale, Pa.

MODEL	DIALS	OHM STEPS	TOTAL OHMS	PRICE
845	3	1	1K	$98.
846	3	10	10K	105.
850	3	100	100K	123.
837	4	0.1	1K	126.
835	4	1	10K	132.
836	4	10	100K	146.
849	5	0.1	10K	162.
848	5	1	100K	176.
839	6	1	1 Meg.	270.

Shallcross



STRESS measurement is simplified with the Model SG-1 unbonded resistance wire Strain Gage. It may be used repeatedly without destruction and is ready for immediate operation upon engaging its knife edge contacts to the specimen. Two active bridge arms are employed. The gage factor of approximately 2.0 permits operation with conventional existing resistance Strain Gage equipment. Two sets of knife edges provide strain measurement ranges of ±0.003 and ±0.012 In./In.

Please write the Engineering Department for data

S-L

Statham
LABORATORIES
• Los Angeles 64, Calif.

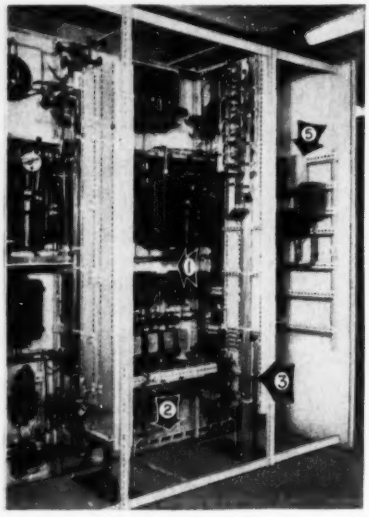
NEW INSTRUMENTS

time. It is for application on low pressures where regulation is required in inches of water: air conditioning, heating, etc. Standard ratings 0 to 20 in. of water pressure with range adjustment and with fixed differentials from 0.2 in. to 2 in. water. Electrical ratings, UL approved, 10 amps. 125 v. or 5 amps. 250 v. a.c.—*The Henry G. Dietz Co.*, 12-16 *Astoria Blvd., Long Island City* 2, *N. Y.*

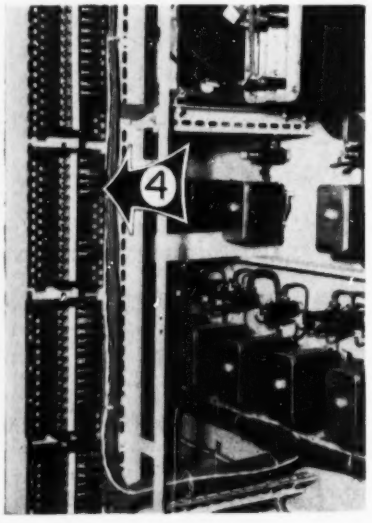
Mention No. 209 when filling out card.

Automatic-control Panels

New automatic-control panels incorporate advances in design and construction: (1) Complete accessibility through the utilization of systematically-spaced vertical support areas which divide panel into bays of associated instruments and operating lines. (2) Control-room floor openings and external



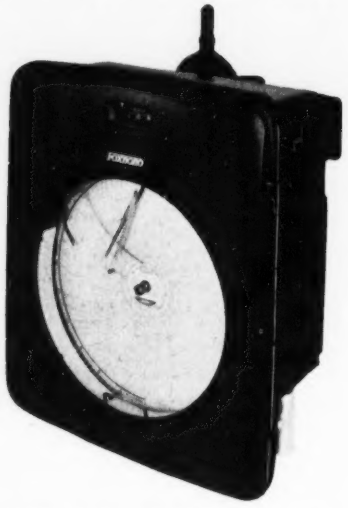
tubing and wiring conduits may be completed well in advance of panel installation. (3) Tubeways have been created to provide centralized distribution points: panel tubing concentrated on vertical supports designed to carry all necessary lines. (4) Wireways enclose well-marked, easily-accessible electrical terminal blocks so that installing, testing, and tracing procedures by user can be done in minimal time; additional terminals added without obstructing existing facilities; individual wire bundles carried out of wireways at points nearest to instrument and switch terminals. (5) Adjustable wall racks facilitate mounting of any make control boxes, alarms, relays, breakers, etc.; permits installing additional equipment without welding special mounting pads to panel walls.—*Bailey Meter Co.*, 1050 *Ivanhoe Rd, Cleveland* 10, *Ohio.*



Mention No. 210 when filling out card.

Pulsation Compensator for Cupola Controller

New compensator in maker's "Model 40" air weight controller for foundry cupolas eliminates effects of blower pulsations on control, makes practical



uniform combustion through control of air weight even where positive-displacement blowers are installed on blast lines. New compensator's function is to automatically correct rate of air flow for variations in atmospheric temperature and pressure. A snubbing device also damps out throbbing effect resulting from use of certain types of blowers and permits controller to respond only to true changes.—*The Foxboro Co., Foxboro, Mass.*

Mention No. 211 when filling out card.

Continuous Weighing System

New conveyor-belt weighing system (developed jointly with Trans-Weigh Co., Wayne, Pa.), applicable for belt-conveyed materials from low-grade ore to refined sugar, continuously weighs material being delivered and provides running measurements of tonnage as well as tons-per-hour. These measurements can be transmitted to foreman's office or to a central control panel board. Chart records are also provided. If one large belt supplies several other belts at different places along its length, new system can add and subtract to measure quantity supplied to any or all belts. New system can also control blending of several different materials on belt. In operation, belt rides over a set of three idlers which form a wide-based trough. Force ex-

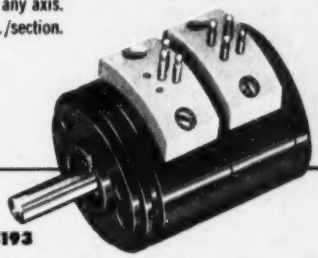
TRULY independent screwdriver Vernier Phasing

MODEL 85194

Self-locking screwdriver-actuated phasing adjustment. Each section easily adjusted to maximum resolution (one wire) in ±11° range. 2½" diameter; ¼" shaft; 2,000 to 300,000 ohms per section; 4 watts @ 25° C; 1 to 6 sections; body length 4.8" max.

SPECIFICATIONS

RESISTANCE: 2,000 to 300,000 ohms/section (±5%).
LINEARITY: ± 0.3% of total resistance.
POWER RATING: 4 watts per section at +25°C ambient.
ELECTRICAL CONTACT ANGLE: 356° standard. (Any winding angle up to 360° on order).
MECHANICAL SHAFT ROTATION: 360° continuous.
TORQUE: Starting torque for 6-section unit: 1.2 oz.-in.
TEMPERATURE RATING: Operating range from −55°C to +71°C ambient.
ACCELERATION: Will function during acceleration of 50G, applied along any axis.
WEIGHT: 4 oz./section.



MODEL 85193

Compact-rugged-accurate. A smaller version of the GANGPOT without the phasing feature. Diameter 1⅛"; ¼" shaft; aluminum housing; 500 to 70,000 ohms per section; 1 to 6 sections; body length 3.5" max.; dual mounting; linear or non-linear windings up to 360° available.

SPECIFICATIONS

RESISTANCE: 500 to 70,000 ohms/section (±5%).
LINEARITY: ±0.5% of total resistance.
POWER RATING: 2 watts per section at +25°C ambient.
ELECTRICAL CONTACT ANGLE: 354° standard (Any winding up to 360° on order), with the brush non-shorting.
MECHANICAL SHAFT ROTATION: 360° continuous.
TORQUE: Starting: less than 0.6 oz.-in. for a 6-section unit.
TEMPERATURE RATING: Operating range from −54°C to +71°C ambient.
ACCELERATION: Will function during acceleration of 50G, applied along any axis.
WEIGHT: 1 oz. per section.

For modifications of standard specifications, please forward requirements.

Specifically designed and built to performance standards far beyond present concepts of potentiometer design, GANGPOT Instrument-Quality potentiometers are ready to solve multiple potentiometer problems. Rugged, aluminum-housed units with low torque, high performance, and long-life accuracy, GANGPOTS are presented in two sizes to fill all requirements. GANGPOT EXTRAS include solid, stainless steel shafts, toroidally wound coils for up to 360° windings, shielded ball bearings, syncro or screw type mounting, and adaptability to non-linear functional windings. Built without any bulky external bolts, clamps or rings, the GANGPOTS lend themselves to an unsurpassed versatility of design applications.

For catalog and engineering data on these and other fine instruments write:

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G. M. GIANNINI & CO. INC., PASADENA 1, CALIFORNIA—EAST ORANGE, NEW JERSEY

SOMETHING BRAND NEW ON THE MARKET!!!

From a modernistic, glass walled factory in the heart of the German-Swiss border country comes an entirely new conception of a calculating machine, available for the first time to American business. Its practical bantam size holds a marvel of minutely accurate machined parts, entirely different in strength and durability from the usual calculating machine's production stamped parts. A proud record of versatile use has built a reputation abroad for this finest bantam precision calculating tool on the market.

The same delicate skill of the trained watchmaker has crafted the Curta "Magic Brain" Calculator into an indispensible machine for computing: addition, subtraction, division, squares, cubes, extracting square roots, percentages, and all other calculating problems that arise every working day. Its compact size in no way impairs its speed of delivery. Compare these estimates with the time it takes you to figure such problems manually in the field, or by using the calculating machine that serves from 5 to 50 people in an average office.

Multiply 645,432 x 63,992—(count your time) Curta gives the accurate answer 41,302,434,544 in 10 SECONDS!

In division, approximately 30 seconds, including setting, are required to ascertain a 6 digit quotient.

Invoicing, calculations of interest, currency or weight and measure conversions, cost accounting, allocating, research and engineering computations are all handled with utmost efficiency by this bantam calculator you can carry in your pocket or brief case, store in a desk drawer, and whose 8 oz. weight is hardly felt.

Taking into consideration the vast differences in temperature and moisture under which their machine must effectively operate, the designers of the Curta Calculator made it of finest grade rust and tropic-proof metals. The lifetime anadized finish is applied electrically.

In the tradition of being the finest bantam calculator on the market, each Curta comes enclosed in a shock-proof metal container with pull-off metal cap. The Calculating face of the Curta "Magic Brain" is a special no glare surface with engraved numerals in contrasting white. Both machine and container are black.

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We will be pleased to send you a new Curta Calculator postpaid to try out on your job. After a thorough 10 day trial, send us your check or return the calculator. NO OBLIGATION.

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DEPT. H, CHICAGO 24, ILL.

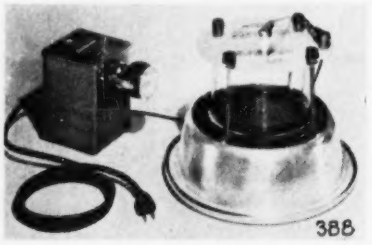
NEW INSTRUMENTS

erted on these is measured by a strain gage and weight of belt itself and other component parts is subtracted electrically. Final measurements (weight of material) are fed into an indicating-and-recording instrument.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

Mention No. 212 when filling out card.

Continuous Cloud Chamber

New "Model 1413 Cloudmaster" continuous cloud chamber enables viewers to "see" radioactivity; requires only dry ice and isopropyl (rubbing) alcohol. Alpha and beta particles from harmless



radioactive source produce tracks as they pass through saturated alcohol vapor within glass chamber. "Cloudmaster" comes complete with a sweep voltage power supply which includes an illuminating spotlight, operates from any 110-volt 60-cycle supply. Radium radiation source contains less radium than an ordinary phosphorescent watch dial.—*Nuclear Instrument and Chemical Corp., 229 W. Erie St., Chicago 10, Ill.*

Mention No. 213 when filling out card.

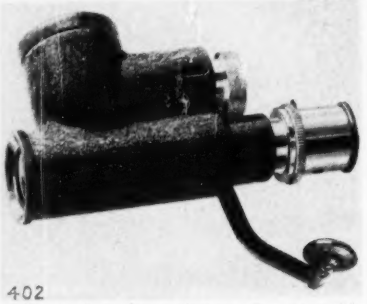
Infrared Gas Analyzer

New "Model 15" infrared gas analyzer, of positive type, is intended for laboratory and experimental purposes; features extreme flexibility, enabling user to adapt it for any gas that can be analyzed by infrared means. Gas for which analyzer is sensitive can be changed by changing detector cell (approx. a ten-minute operation). Length of absorption cell and filter cell when required can be varied from 0.05 in. to 12 in. to cover full-scale concentration ranges from 100 percent to 0.05 percent for most gases. Instrument enables user to evaluate an analysis problem in his own laboratory before purchasing a plant control instrument.—*Liston-Becker Instrument Co., Inc., 20 Beckley Ave., Stamford, Conn.*

Mention No. 214 when filling out card.

Portable Spectrometer and Visual Colorimeter

New "Spectron Comparison Spectrometer" simplifies qualitative analysis of metallic elements. To identify an element, it is only necessary to note wavelength of its spectral lines on a



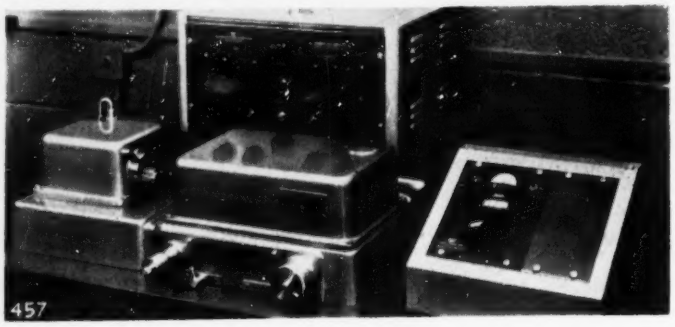
calibrated scale and to refer to table supplied with instrument. Unique optical system permits two spectra to be viewed simultaneously against a superposed wavelength scale calibrated to read directly in millimicrons. Spectrum of a known element may thus be compared with unknown, further simplifying analysis A cuvette attachment furnished with "Spectron" adapts it for use as a visual colorimeter for testing absorption spectra of liquids. "Spectron" covers entire visible range from 4000 to 8000 Angstroms. Dispersion C-F is 13 deg. Wavelength scale may be adjusted to sodium line D and can be read with an accuracy of 1 millimicron.—*National Instrument Co., 5005 Queensbury Ave., Baltimore 15, Md.*

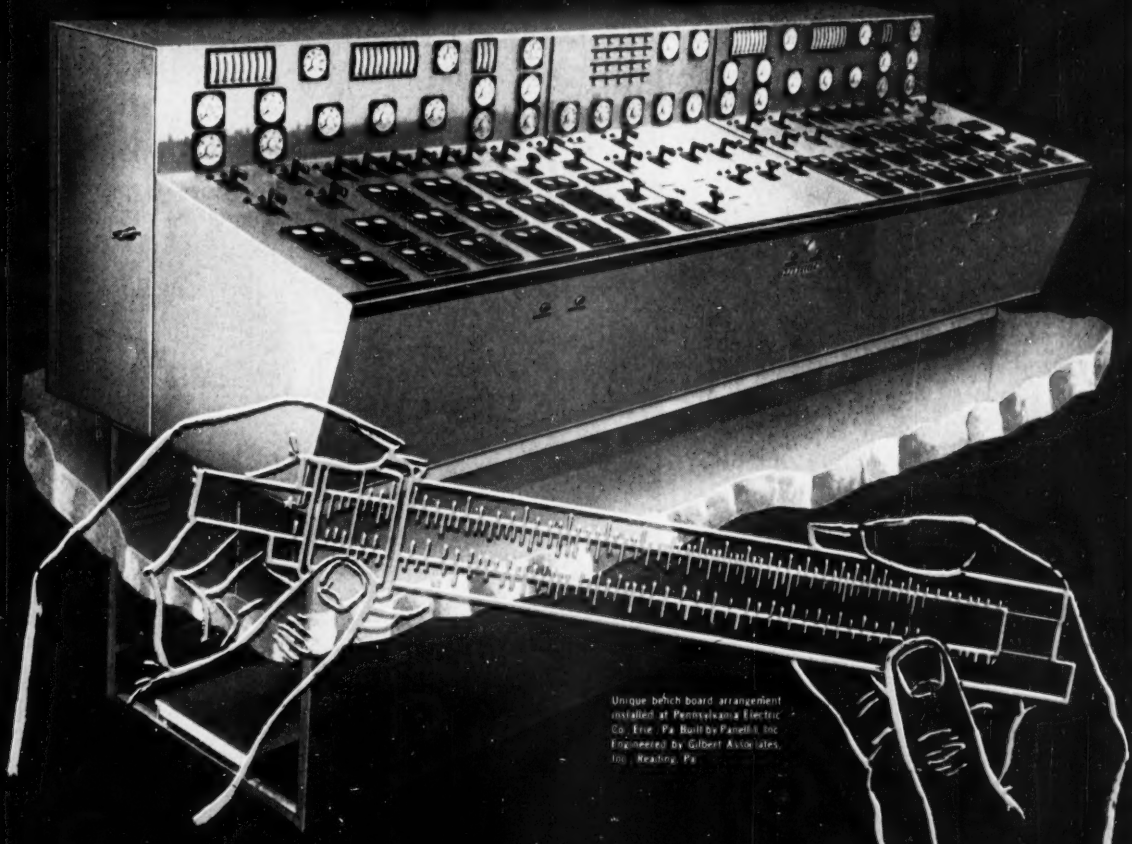
Mention No. 215 when filling out card.

Infrared Spectrometer

New "Model 112-S" infrared spectrometer, for routine single-point chemical analyses accurate to 0.25 percent, is a simplified version of maker's "Model 112." Any wavelength within range of prism may be quickly selected. Unique double-pass optics reduce scattered radiation to less than 0.1 percent. "Model 112-S" is available in three wavelength ranges: near infrared (0.5 - 2.5 microns); fundamental region (2 - 15 microns); far infrared (15 - 38 microns). It is convertible from one spectral region to another, also to an automatic recording instrument by adding proper accessories.—*The Perkin-Elmer Corp., P. O. Box 730, Norwalk, Conn.*

Mention No. 216 when filling out card.





Unique bench board arrangement installed at Pennsylvania Electric Co., Erie, Pa. Built by Panellit, Inc. Engineered by Gilbert Associates, Inc., Reading, Pa.

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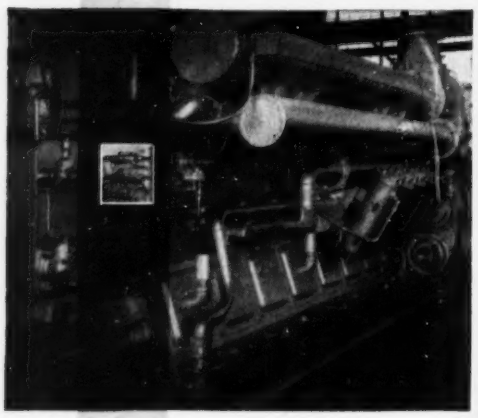
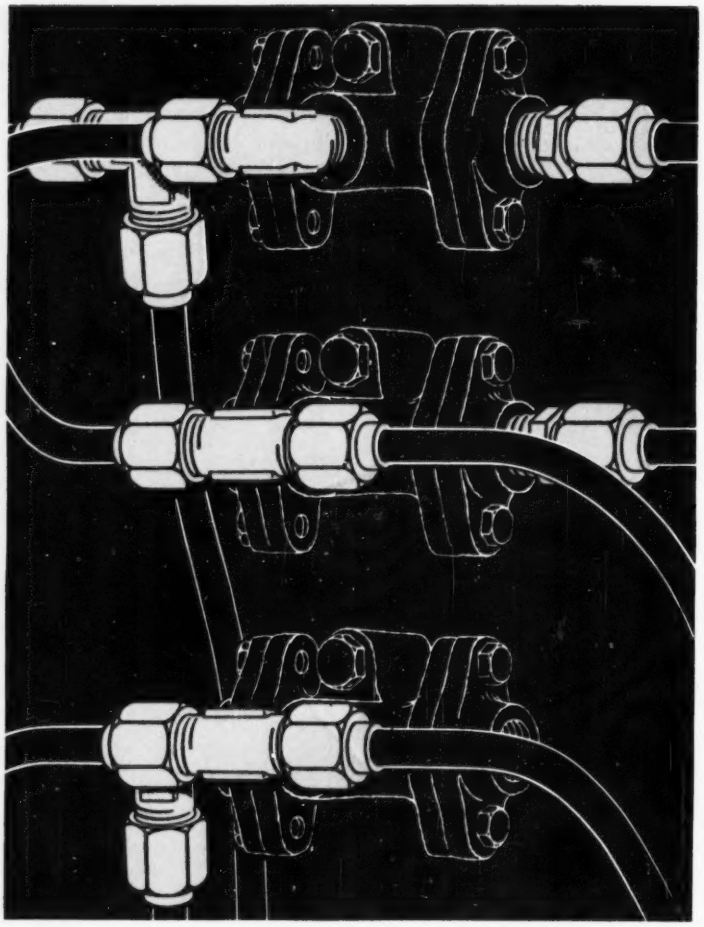
ON DIESEL ENGINES



This typical Diesel engine manufactured by The National Supply Company, Engine Division, Springfield, Ohio, is equipped with Parker Triple-lok Fittings.



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HOUSTON 1, Tex.—Standard Brass & Mfg. Co. 2018 Franklin St.
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NEWPORT NEWS, Va.—Noland Co., 27th St. & Virginia Ave.
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NEW YORK 14, N. Y.—Whitehead Metal Products Co. 303 West 10th St.
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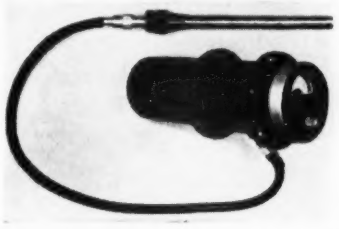
SHREVEPORT, La.—Standard Brass & Mfg. Co. 1557 Texas Ave.
ST. LOUIS 15, Mo.—Metal Goods Corp., 5239 Brown Ave.
SYRACUSE 4, N. Y.—Whitehead Metal Products Co. 207 W. Taylor St.
TOLEDO 2, O.—Williams & Co., 650 E. Woodruff Ave.
TULSA Okla.—Ardun Supply Co., 317 S. Detroit
TULSA 3, Okla.—Metal Goods Corp., 302 North Boston
CANADA—Railway & Power Engineering Corp. Ltd.
EXPORT—Mercator Corp., 438 Walnut St., Reading, Pa.

NEW INSTRUMENTS

Level Controller

New "Ktrol" automatic level controller, for non-conductive materials ranging from condensed gases to semi-solids, particularly in high-temperature and

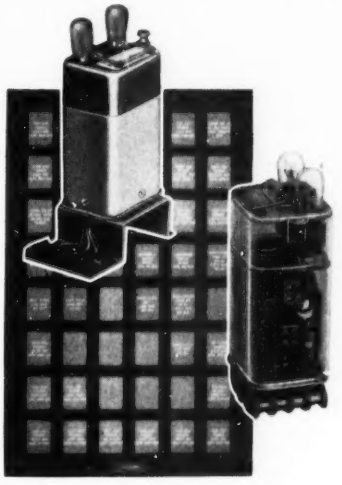


high-pressure applications, is a compact unit with plug-in sealed housing which can be replaced in a matter of seconds. Exchangeable sealed component units are available for insertion in control without disturbing or removing equipment from tank or vat. Electronic circuit will maintain level control from plus or minus 1/16 in. and up. Custom-built non-corrosive probes are available for particular material and tank or container. "Ktrol" is available in an oil-filled housing for explosion-proof installation. Controller can be installed in field without adjustment; operates from a standard light circuit. —*Greylor Co., 605 W. Washington Blvd., Chicago 6, Ill.*

Mention No. 217 when filling out card.

Alarm System

New "Model LPG Tel-Alarm" all-purpose enclosed signal relay units employ the same relays and other parts as used in maker's hermetically-sealed

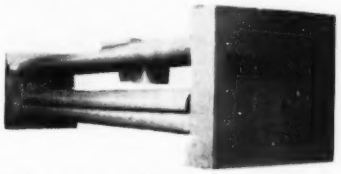


models, but are dust-proof and may readily be taken apart. More than 100 standard circuits are available, many with universal features permitting field changes in operating sequences with simple terminal connections. Unitized system of construction permits assembly into any number of multiple stations from a single unit to many hundreds in same system.—*Tigerman Engineering Co., 4332 N. Western Ave., Chicago 18, Ill.*

Mention No. 218 when filling out card.

Beta Gage for Wide Sheet Materials

New model of "AccuRay" beta-gage enclosed-bracket mounting is designed for use in such industries as paper, plastics, and floor tile where large sheet



widths (up to 100 in.) are not uncommon. It permits source of radiation and detector unit to travel back and forth across sheet on separate arms and never vary their alignment.—*Industrial Nucleonics Corp., 1205 Chesapeake Ave., Columbus, Ohio.*

Mention No. 219 when filling out card.

Electric-contact Type Automatic Controller

New electric-contact type automatic temperature controller for commanding solenoid valves, warning signals and motors, is vapor-actuated, is designed

to stand a fairly heavy electrical load. Among features is a red and green pilot light to show switch position at a glance. Standard controllers operate on 115 volts a.c. When specified, controllers can be furnished for currents up to 250 volts a.c. or d.c. Load limits: 500 watts a.c. and 50 watts d.c. Seven temperature ranges are available, between extremes of −20 F. and +450 F.; also seven corresponding C. ranges.—*H. O. Trerice Co., 1420 W. Lafayette Blvd, Detroit 16, Mich.*

Mention No. 220 when filling out card.

Electric-contact Type Automatic Controller

New "Simplytrol Contact Meter Relay with Booster Contacts" is available in same sizes, ranges and styles as maker's standard "Simplytrol" contact-type instrument, but provides greater capacity: In new model, instrument contacts and locking coil provide only the actuating force for an extra pair of contacts which carry the load. These booster contacts are carried on frame inside case; are independent of moving system but are actuated by it. Load contacts can be designed for best current

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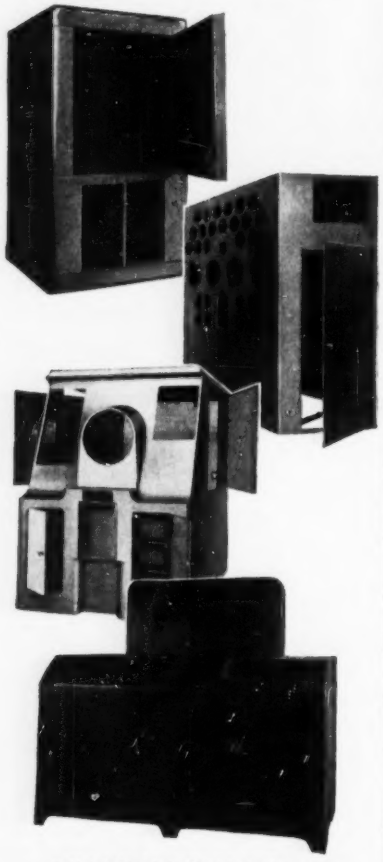

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LITTLEFORD BROS., INC.
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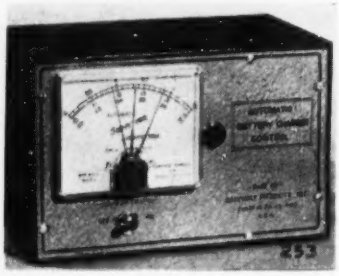
NEW INSTRUMENTS

rating. Since they will be closed with considerable pressure, a contact alloy can be chosen which will withstand arcing and carry heavier currents and operate at higher voltages. Contacts can be used on either a.c. or d.c.; can be isolated from input circuit without use of extra hair-springs. Contact locking circuit as well as input can be designed for a-c. operation in conjunction with rectifiers inside case. New controller can handle 110-volt a-c. loads directly without auxiliary equipment.—*Assembly Products, Inc., Chagrin Falls, Ohio.*

Mention No. 221 when filling out card.

Automatic Battery-charger Controller

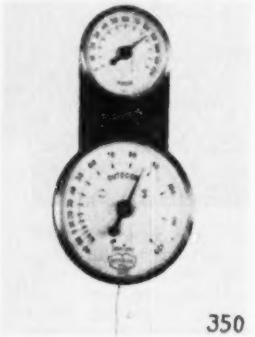
New "Model 3577 Simplytrol" automatic controller for plant and lab battery chargers takes out guesswork. It is connected across line so that batteries need not be disconnected for charging. Control action is initiated by a double-contact instrument with suppressed zero range 5 to 7.5 volts. High and low limit load relays, interlocked, work in conjunction with instrument contacts. A transformer, with rectifiers and filter, furnishes power for load relays, also isolates charging circuit from a-c. line.—*Assembly Products, Inc., P.O. Box* 191, *Chagrin Falls, Ohio.*



Mention No. 222 when filling out card.

Indoor-outdoor Thermometer

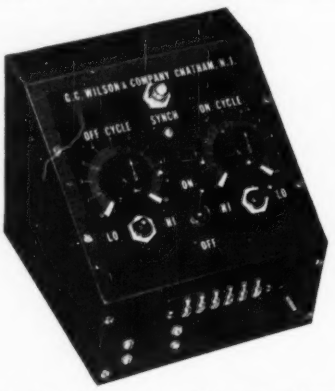
New "Twin-Temp" indoor-outdoor thermometer has two dials, which give quick, comparative readings of indoor and outdoor temperatures and can be easily read at a distance. Accuracy and sensitivity are said to be "equal to that of high-grade scientific instruments."—*Weksler Thermometer Corp.,* 49 *W. 32nd St., New York* 1, *N. Y.*



Mention No. 223 when filling out card.

Automatic Repeat Timer

New automatic timer, of repeat-cycle type, is for regulation of automatic machinery, sampling, valve pacing and heat sealing as well as laboratory testing. It uses a single electron tube to charge a resistance-capacitance network so that "on" cycles are adjustable from 0.2 to 200 seconds and "off" cycles range from 0.1 second to 1 minute. Unit operates on 105-120 volt, 60 cycle a.c. Output is supplied to a d-p.d-t. relay for non-inductive loads up to 10 amperes at 115 volts or 2 amperes at 460 volts.—*G. C. Wilson & Co.,* 2 *N. Passaic Ave., Chatham, N. J.*



Mention No. 224 when filling out card.

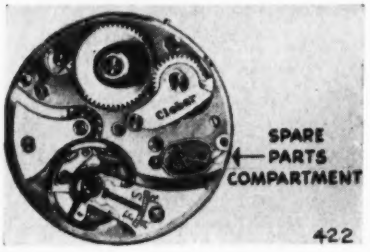
Aromatic-hydrocarbon Detector

New "MSA Aromatic Hydrocarbon Detector," for measuring atmospheric concentration of the aromatic hydrocarbons—benzene, toluene, xylene—is based on a specific color reaction on a gel surface. (Combustible-gas indicators commonly used for determining lower explosive limits of certain gases and vapors cannot separate aromatic-hydrocarbon components from other combustibles in contaminated air.)—*Mine Safety Appliances Co., N. Braddock Ave., Pittsburgh, Pa.*

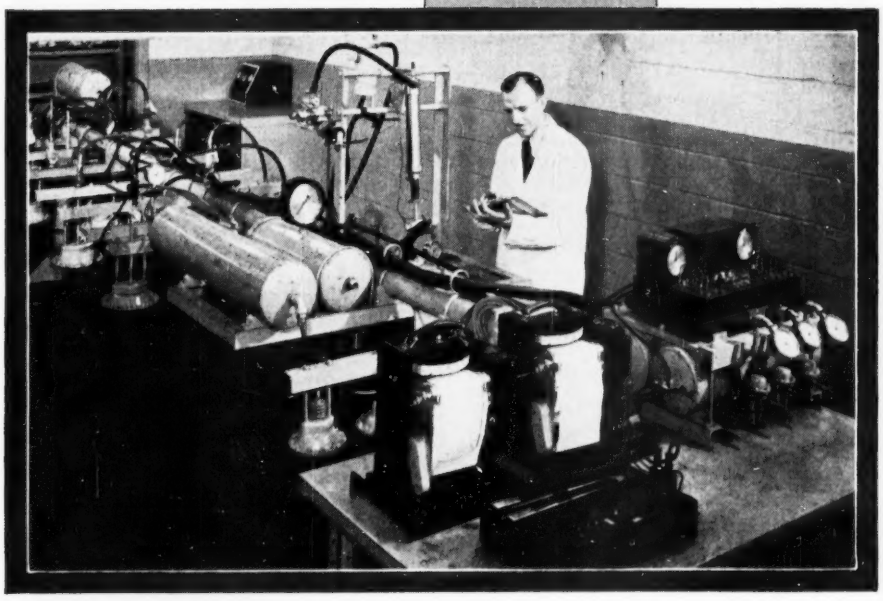
Mention No. 225 when filling out card.

Stopwatches with Spare-part Compartment

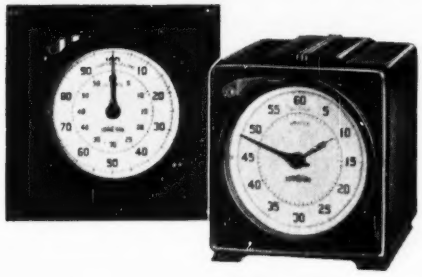
New stopwatches and timers have a tiny compartment containing seven spare watch parts, always available



TIME TO STOP...IN TIME!



SPLITTING THE SPLIT SECOND at the Bendix-Westinghouse Engineering Research Department laboratories is absolutely essential in exploring every possible braking requirement for transportation tomorrow.



STANDARD ELECTRIC TIME has been serving industry, government and educational institutions for almost seventy years with fine precision instruments and equipment for the accurate measurement of time.

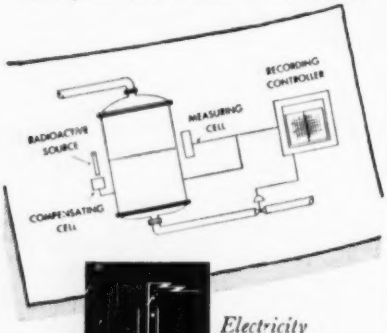
STANDARD ELECTRIC MODEL S-1 Clocks are a part of the modern laboratory controls testing equipment and timing devices shown in this photograph... they accurately measure air brake application and release transmission time to one-hundredth of a second... The timers are started instantaneous to brake pedal movement transmitted through an electronic circuit and are stopped by means of a highly sensitive electro pneumatic switch located at pre-determined stations in the air brake system.

STANDARD
SINCE 1884

THE STANDARD ELECTRIC TIME COMPANY
93 LOGAN STREET • SPRINGFIELD 2, MASSACHUSETTS

see into steel tanks

New Ohmart Density Gauges "see" into steel vessels—simply and directly perform many "hard-to-do" measurement tasks with amazing accuracy! The penetration power of radioactivity is utilized to make *easy* many different evaluations of process variables, up to now difficult or impossible because of such conditions as extreme temperatures or pressures, or corrosive or erosive elements. A typical application is shown in the diagram below—where the Ohmart Density Gauge is used for liquid level measurement. Operation is simple—standard electronic instruments are used; equipment is sturdy and easily installed (usually with NO connections into the vessels themselves); only small, *safe* quantities of radioactivity are required. If you have any difficult process variables evaluation problem, where density is a function of the desired measurement, look to Ohmart Density Gauges for your solution. Write today for information, consultation.



Electricity From Radioactivity

the ohmart corp.

2335 FERGUSON ROAD
CINCINNATI 38, OHIO

DALLAS CHICAGO

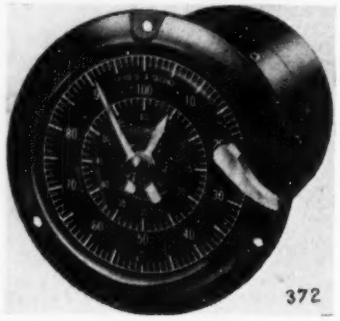
NEW INSTRUMENTS

for replacement. "Every local jeweler thus becomes a repair station."—*Clebar Watch Agency, 521 Fifth Avenue, New York 17, N. Y.*

Mention No. 226 when filling out card.

Elapsed-time Indicator

New "Type ET Time Totalizer," for indicating elapsed time intervals, is available in two models: One has scale divisions of 0.01 second and a total range of 60 seconds, the other has divisions of 0.01 minute and a total range of 60 minutes. Accuracy for either is better than 0.02 percent. Instead of conventional friction clutch, motor is permanently connected to sun gear of a differential gear system. One differential member is connected to pointer system; other goes to a free gear. When timer is energized, a solenoid-operated pawl stops free differential member and power is immediately transferred to pointer differential member. When timer is de-energized, a pawl engages pointer gear, stopping it instantly, while free differential member is simultaneously released. This arrangement insures positive, accurate clutching without slippage or over-run. Other features: meter-type housing for panel installation or where space is limited; maker's high-torque synchronous motor; forms available to meet military specifications with regard to shock, vibration, temperature, etc.—*R. W. Cramer Co., Centerbrook 5, Conn.*



Mention No. 227 when filling out card.

Vertical Drafting Machine

New counterbalanced vertical drafting machine unit features an elbow brake and a drafting head engineered

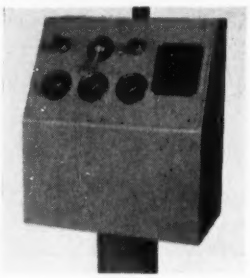
Immersion Thermocouple

New "Stamco Immersion Thermocouple" for molten-metal temperature measurements features light weight and a construction that permits easy and quick overhaul, said to result in long life and low cost per reading. Accuracy is reported as "plus or minus 10 degrees."—*Standard Tool and Machine Co., Blawnox, Penna.*

Mention No. 228 when filling out card.

Well-drilling Controller

New "Ideal Micromatic Drilling Control" will either (1) maintain a predetermined weight on a drilling bit, or (2) feed off drilling string at a predetermined rate of bit penetration; can be supplied with new "Ideal" rigs of larger sizes, is also adaptable to existing rigs that have conventional independently-mounted "Hydromatic" or "Dynamatic" auxiliary brakes. It eliminates much physical effort and attention, freeing driller for supervisory or other duties. It imitates time-honored method of driller as he manipulates drawworks brakes while watching needle on a weight indicator. Design is based on principle that load on drilling string is always under direct control of a simple mechanical brake, which is normally urged toward "on" position. Any failure of system automatically applies brake, making it impossible to drop drilling string.—*National Supply Co., Gateway Center, Pittsburgh 30, Pa.*



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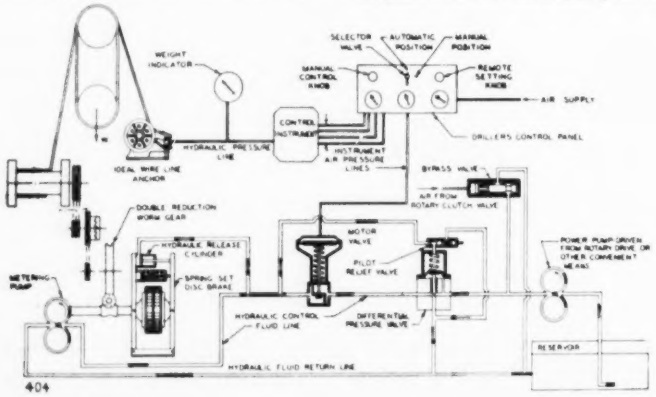
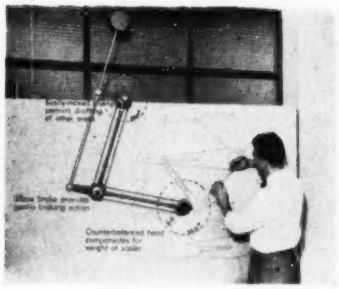


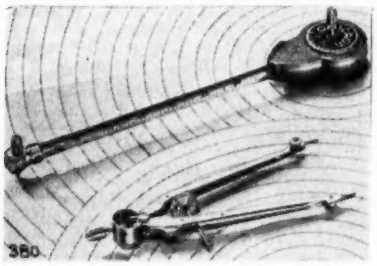


to counterbalance the scales. Head on which scales fit is balanced for use with any type of 12 in. (vertical) or 18 in. (horizontal) scale. Counterweight may be adjusted to fit other sizes of scales. New machine is available with standard or civil engineer head and with 24-in. or 30-in. arms.—*V & E Mfg. Co., Box 950M, Pasadena 20, Calif.*

Mention No. 230 when filling out card.

Compasses

New "Omicron" beam compass of 72-in. radius capacity has steel beam on edge assuring parallelism of center-pin and scriber; also positive locking in

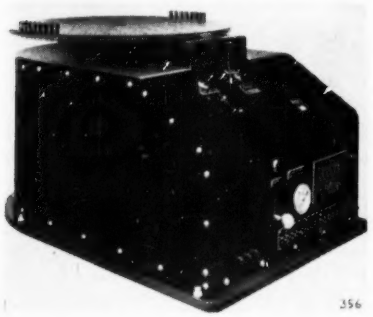


any dimension and, by pumping locking lever, minute adjustments. No separate parts to put together. One-hand operation. Also announced is "Omicron Model 12" bow compass with double adjustment: to open, press trigger; to close, press legs together. Less than a second to change settings. Positive lock and fine adjustment.—*A. Partrick Co., P. O. Box 28, Westwood, N. J.*

Mention No. 231 when filling out card.

Gyro-instrument Calibrator

New model of rate-of-turn table with 24-in. cast-aluminum table, for calibrating and evaluating rate gyros and associated equipment, features a specially-developed drive system without gearing and free from backlash, whose output to table is continuously variable from 0.01 deg/sec to 1200 deg/sec by means of a single control which makes 36 turns for full-scale traverse. Drive is powered by a synchronous motor op-



STRUTHERS-DUNN

Standard relays and timers match 4 out of 5 requirements

5,348 RELAY TYPES

S-D

STRUTHERS-DUNN, INC., 150 N. 13th St., PHILADELPHIA 7, PA.

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THE RAYONIC®

CATHODE RAY TUBES

BY WATERMAN

Since the introduction of Waterman RAYONIC 3MP1 Tube for miniaturized Oscilloscopes, Waterman has developed a rectangular Tube for multi-trace oscilloscopy. Identified as the Waterman RAYONIC 3SP, it is available in P1, P2, P7 and P11 screen phosphors. The face of the Tube is 1½" x 3" and the over-all length is 9⅛". Its unique design permits two 3SP Tubes to occupy the same space as a single 3" round tube, a feature which is utilized in the S-15-A TWIN-TUBE POCKETSCOPE. On a standard 19" relay rack, it is possible to mount up to ten 3SP tubes with sufficient clearances for rack requirements. Thus 3SP RAYONIC tube is ideal for multi-trace oscilloscopic work.

Maximum 2nd anode voltage 2750 volts ... Satisfactory operation can be achieved at 600 volts ... Vertical deflection factor 52 to 70 volts DC per inch per kilovolt ... Horizontal deflection factor 73 to 99 volts DC per inch per kilovolt ... Grid cut-off voltage 2.8 to 6.7% of 2nd anode potential ... Focusing voltage 16.5 to 31% of 2nd anode voltage ... Heater 6.3V at .6 amp ... Twelve pin small shell duodecal base ... Tube can be mounted in any position ... 3SP1 JAN approved.

WATERMAN PRODUCTS CO., INC.

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WATERMAN PRODUCTS INCLUDE:

3JP1 & 3JP7 JAN RAYONIC CR TUBES
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3RP1, 2, 7, 11 RAYONIC CR TUBES

Also POCKETSCOPES, PULSESCOPES, RAKSCOPES and other equipment

WATERMAN PRODUCTS

NEW INSTRUMENTS

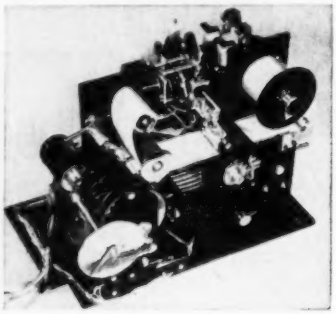
erating from line frequency. Speed indicator drum is augmented by a built-in line frequency strobe lamp focused on engraved rim of the table. Stroboscopic harmonics occur at 10 deg/sec intervals beginning at 10 deg/sec rate, and will be accurate to within 0.1 percent in most parts of U. S. Performance measurements show that this model has successfully minimized vibration and wow conditions. Sixteen electrical slip ring circuits, individually shielded and of extremely low noise level, terminate at 5-way binding posts on console panel and on table top.—*Dep't 1, Genisco Inc., 2233 Federal Ave., Los Angeles 64, Calif.*

Mention No. 232 when filling out card.

COMPUTING DEVICES

Digital-printing Recorder for Analog Data Inputs

New "Ametron" recorder simplifies measurement of continuous-series magnitudes and numerical printing of resulting quantities. A basic unit can be

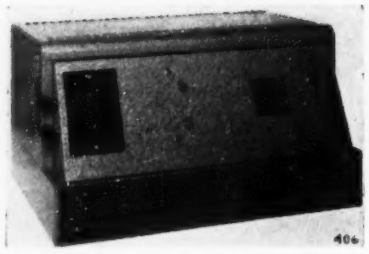


adapted to print numerical values of a variety of magnitudes such as temperature, distance, speed, etc., capable of being converted into corresponding voltages. Other features which may be incorporated into instrument include multi-channel operation, automatic print actuation, time index print, identification index print, zero balance adjustment, visual dial; also various computing components for addition, subtraction, division, multiplication, integration, etc.—*Streeter-Amet Co., 4101 Ravenswood Ave., Chicago 13, Ill.*

Mention No. 233 when filling out card.

Electromechanical Integrator

New automatic electromechanical unit based on standard computer techniques provides time-integral of any d-c. input function. Applications include continuous process weighing; integration of stress-strain curves; analysis of graphical data; integrating rocket thrust; total water content determination; totalizing illumination; weathering or fading tests; and integration of two independent variable signals with respect to each other (*X-Y* integration independent of time). Unit is said to combine advantages of mechanical and electronic integrators to give high-speed response, long time stability, and unlimited output in one instrument. Principle: A measure of time integral of input is registered on

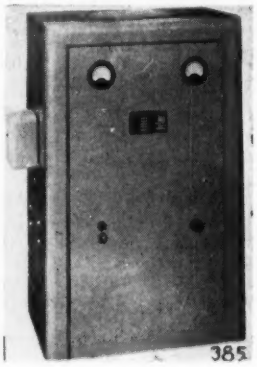


a mechanical revolution counter geared to output. Output speed is made directly proportional to integrand input signal through an accurately-controlled variable-speed drive with tachometer feedback. In addition, an electronic integrator instantaneously integrates any transients or tachometer-response errors and applies this correction factor. When unit is used with a potentiometer recorder, signal is derived from a multi-turn potential divider which can be supplied from a stabilized voltage source incorporated in unit. Integrator is available in one- or two-counter models. Two-counter model (shown) incorporates electric clutches and can be operated either manually or automatically from some auxiliary switching function (useful, e.g., for integrating successive portions of a curve separately).—*Instron Engineering Corp., 2 Hancock St., Quincy 71, Mass.*

Mention No. 234 when filling out card.

Precision Power Supply for Computers, etc.

New "Precision Power Supply" is a high-power d-c. source, designed especially for digital and analog computers, business machines, etc. It provides dynamic regulation of better than 0.2 percent with wide load and a-c. line

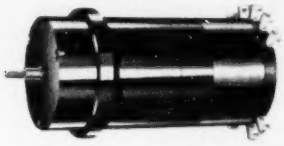


changes; steady-state regulation less than 0.15 percent from no-load to full-load with plus or minus 10 percent a-c. line voltage. Rms. ripple can be filtered as low as 0.01 percent; with 0.5 percent as standard. High efficiency (approx. 75 percent) assures sufficiently cool operation to minimize refrigeration requirements in office-installed computers. Maker points out that a computer cannot function properly if power supply creates artificial spikes because of changes in load or in a-c. line. Standard ratings from 6 to 500 volts d.c. and from 5 to 200 amps.; others to order.—*Inet, Inc., 8655 S. Main St., Los Angeles 3, Calif.*

Mention No. 235 when filling out card.

Resolver Systems

New electrical resolver system, developed for use in computing systems, comprises a resolver, a high-gain amplifier, and a summing network box. Net-



work box suitably combines its inputs for introduction into high-gain amplifier; amplifier feeds resolver (either Basic Resolver or Vector Solver type); outputs of resolver are the desired functions. System was designed originally for armed services, operates accurately at temperatures from −60 to +160 F.; is standardized to allow interchangeability without upsetting system of which it is a part. Through a choice of network boxes and amplifiers, many different types of problems may be solved by minor equipment substitutions.—*Ford Instrument Co.*, 31-10 *Thomson Ave., Long Island City* 1, *N. Y.*

Mention No. 236 when filling out card.

FOR THE LABORATORY

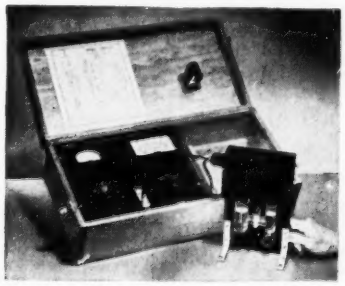
Transmission-type Interference Filters

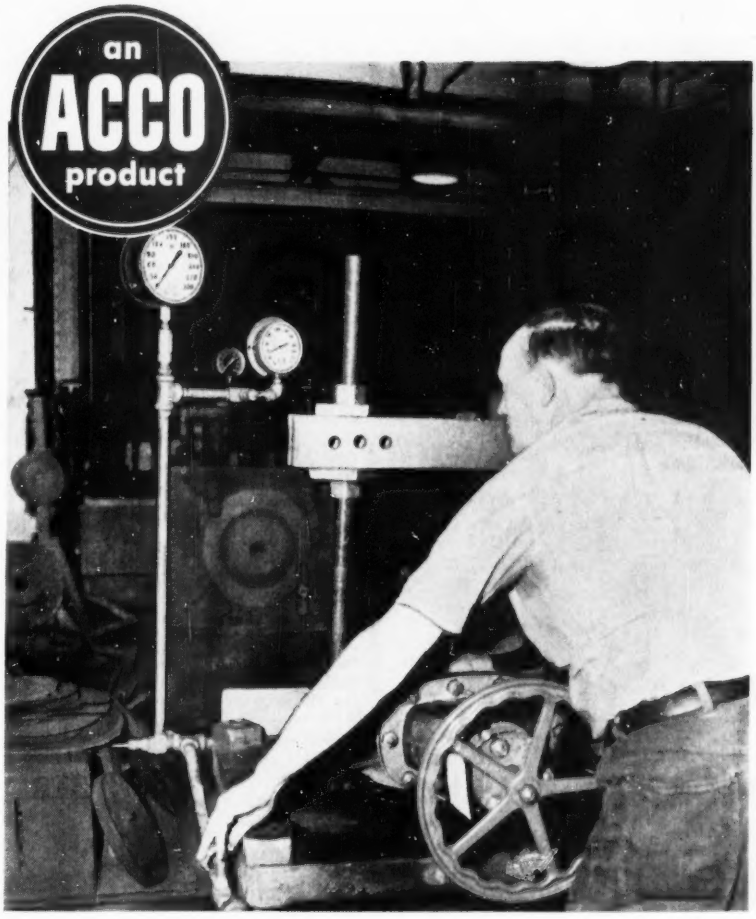
New transmission-type interference filters, isolating specific spectral bands, are for use in colorimetry, color densitometry, photomicrography, and flame photometry. Each filter consists of two highly reflecting but partly transmitting films of silver separated by a spacer film of non-absorbing material, deposited on a two-inch-square glass plate by maker's high vacuum methods. Depth of separation of silver films by spacer film governs wavelength position of pass band. Wavelengths carried in stock extend over range of 340 to 800 millimicrons.—*Bausch & Lomb Optical Co., Rochester, N. Y.*

Mention No. 237 when filling out card.

Dissolved-oxygen Analyzer

New "Dissolved Oxygen Analyzer," for rapid oxygen determinations in aqueous solutions, is not subject to interference by dissolved iron, calcium, magnesium, or organic matter. It is self-contained in a cabinet 22 x 11 x 7 in. Readily-obtainable batteries have practically shelf life. Analyzer uses amperometric principle in which traces





Why HELICOID Gages Prove So Dependable, So Much Longer...

● Hydrostatic testing of valves on production lines gives gages a continuous workout. Every few minutes, all day long, high pressure water is run into valve after valve. Each time the gage surges up, levels off, and then suddenly drops back to zero.

Wear on gear teeth would be a constant headache—BUT not with a HELICOID Gage because—*it doesn't have teeth!* A simple stainless steel roller and long life cam absorb the surges and practically eliminate wear. Consequently, a HELICOID Gage after thousands of cycles is just as good as the day it was made.

Here you see Helicoid Gages on a hydraulic application. You can also get HELICOID Gages for pressure, vacuum, or compound service—in all pressure ranges; in various sizes and shapes; with black, white, and radiant faces; wall, stem, flush, and panel mountings, or flangeless cases.

Write today for full details on HELICOID Gages —they retain original accuracy longer, last longer, cost less per gage, per year.

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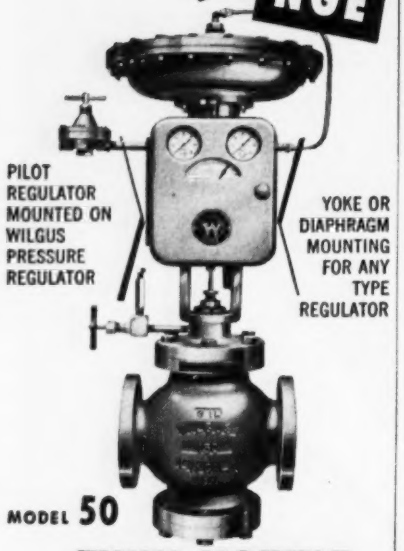

MODEL 50

TWIN NOZZLE PILOT REGULATOR

Controls pressures up to 1000 pounds without changing Bourdon Tube...

Here is a new, simplified, pilot regulator that provides direct or reverse pilot action, by simply changing the supply and diaphragm tubes from one position to another! The Wilgus NGE twin-nozzle pilot regulator incorporates a Bourdon tube, of highly corrosive-resistant nickel alloy, to vary the flow of the pilot supply medium through a nozzle mounted in a twin-nozzle block. This combination direct-and-reverse-acting nozzle block is integral with the control setting mechanism. Simply change the supply and diaphragm tubes from one position to another, and you accomplish the desired results of reverse action in a matter of a few minutes.

Sturdy and precision made throughout. Highly sensitive yet ruggedly constructed. Fully described and illustrated in Wilgus NGE Bulletin No. 614. Write for your free copy today.

Manufactured by

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LOS ANGELES, CALIFORNIA

Sold Nationally by

Natural Gas Equipment, Inc.
190 East Glenarm St., Pasadena, Calif.

Available from

Automatic Specialties Co., Pittsburgh, Penna.
Gulf Coast Machine & Supply Co., Houston and Beaumont, Texas

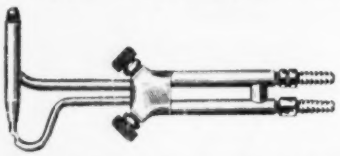
NEW INSTRUMENTS

of dissolved oxygen are reduced at a rotating platinum cathode. (Rotating-electrode assembly on a detachable frame can be used for other analyses if desired.) Sample is placed in a plastic container which is then attached to instrument. This provides a reading which is converted to ppm dissolved oxygen by means of a calibration chart. Complete interference-free determinations can be made in 10 to 30 seconds, correct within 5 percent for most solutions.—*Dorber Co.*, 7741 *W. Palatine Ave., Chicago* 31, *Ill.*

Mention No. 238 when filling out card.

Blow Torch

New "RV-2000" blow torch, designed to burn any type of gas with oxygen, for Pyrex and Vycor, and hydrogen and oxygen for quartz, provides all

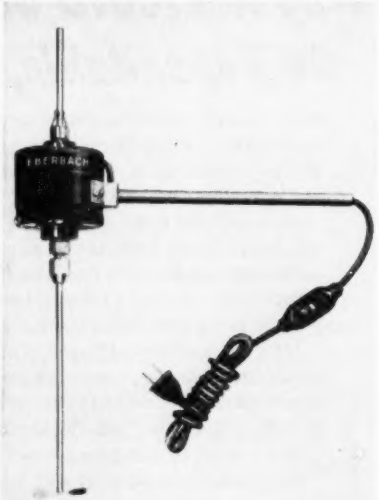


working flames from small to large sealing, a wide range of annealing, as well as long wide brush flame. Gases are thoroughly mixed in burner assembly (not at valve assembly) and are noiselessly burned at tip. Owing to internal construction of burner assembly, torch is fool-proof and will not back up and explode in line.—*Research Vacuum Supply Co.*, 3434 *Montrose Ave., Chicago* 18, *Ill.*

Mention No. 239 when filling out card.

Laboratory Stirrer

New "Hollow Spindle" laboratory stirrer has propeller which can be raised or lowered while motor remains

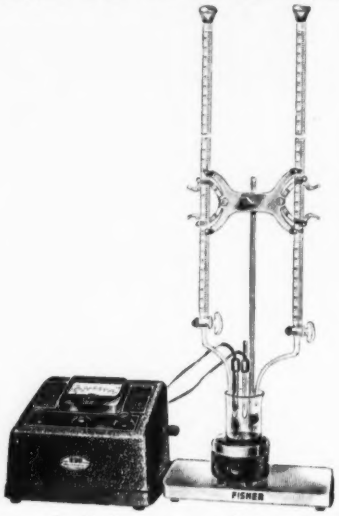


in a fixed position. Operator can vary working length according to size of vessel employed, and place and remove containers by raising propeller only. Noiseless and sparkless 1550 r.p.m. shaded-pole motor develops torque of 5.195 inch-ounces.—*Eberbach Corp., Ann Arbor, Mich.*

Mention No. 240 when filling out card.

Titration Assembly

New "Titration Curve Assembly" uses a pH-meter to assist chemists in setting up controls on any variety of samples. It includes maker's burette stand with burette holder, two burettes with curved delivering tips, an electrode support, a 250-ml beaker. "Heart" of assembly is a new magnetic stirrer equipped with two stirring magnets,



one polyethylene, one glass-enclosed, which operates on 115-volt 50-60 cycle a-c. "Brain" of assembly is a Beckman pH meter. "Assembly 1" is built around Beckman "H-2" temperature-compensated direct-reading pH meter that can be operated for 24-hour periods. "Assembly 2" is built around portable battery-operated, Beckman "N-1" pH meter. (For laboratories already owning a pH meter, set of titration curve accessories alone is also available.)—*Fisher Scientific Co.*, 717 *Forbes St., Pittsburgh* 19, *Pa.*

Mention No. 241 when filling out card.

Freezing Stage for Microscopes

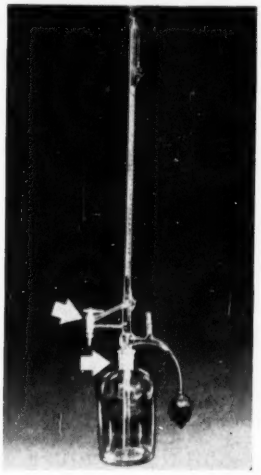
New "Kofler Micro Freezing Stage" is for microscopic observation of organic and inorganic substances at con-

trolled temperatures. Lowest attainable temperature is about –50 to 55 C. and maximum approx. +40 C.—*William J. Hacker & Co., Inc., 182 Beaver St., New York 5, N. Y.*

Mention No. 242 when filling out card.

Automatic Burettes

New "Teflomatic" automatic burettes are available in two models: "TJ-715" for acids (illustrated) and "TJ-740" for alkali solutions. Both are similar

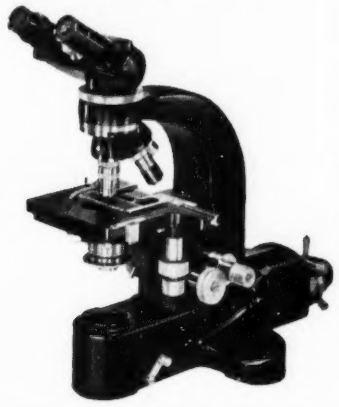


to maker's standard automatic burettes but they differ in that "Teflomatic" has a solid Teflon plug which prevents sticking or binding; and joint is Teflon-coated so that burette cannot freeze to bottle.—*Scientific Glass Apparatus Co. Inc., Bloomfield, N. J.*

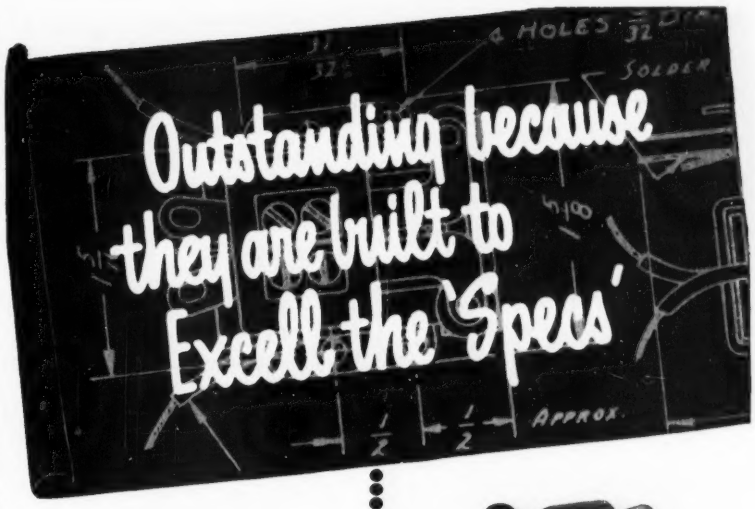
Mention No. 243 when filling out card.

Microscope for Research and Phase Contrast

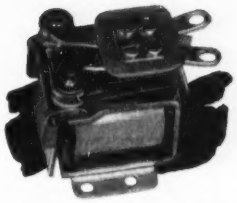
New "Dialux" is available as a research microscope or as a phase microscope. Head features an unusual bayonet clamping arrangement instead of



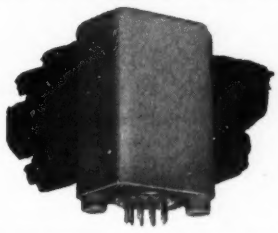
a dovetail slider, thereby facilitating quick and safe interchange of basic units such as nosepiece and body tube. Tube may be revolved full 360 deg. Substage condenser slides horizontally out of a dovetailed fork, and a safety looking device prevents vertical or horizontal movement of mechanical stage. "Dialux" is designed for use in transmitted light and is available with 4 apochromatic objectives, 4 achromatic



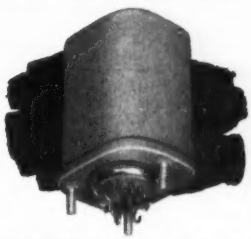
R 45 SERIES—Small telephone type relay with pin hinge construction. Available with multiple contact springs up to six pole double-throw. Capacities: 1 amp., 3 amp., or 5 amp. Normally supplied for D.C. operation. Hermetically sealed or open. 1-13/32x1-1/4x1-7/32 to 1-5/8 high.



R 83 SERIES—Available with A.C. or D.C. coils. Contact ratings up to 30 amperes continuous, 150 amperes inrush with single pole double-break arrangement. Multiple contact springs with proportionately lower ratings also available. Size: 1-7/8x1-5/16x1-5/8 high.



R 94 SERIES—Hermetically sealed small telephone type relay with pin hinge construction for long life. Available in D.C. only with contact springs up to 4 pole double-throw. In 1 amp., 3 amp., or 5 amp. capacity. Plug-in or solder terminals. Overall size 1-5/8 x 1-1/32 x 2-1/4 D.



RB 45 SERIES—Similar to R 45 with the exception that it is designed to fit the hermetically sealed enclosure shown. Three stud mounting; solder terminals. Available up to 4 pole double-throw. Widely used in aircraft and ground communication equipment. Size: 1-5/8 x 1-7/16x2-1/32 D.

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objective fluorite lenses or complete phase contrast equipment. It comes equipped with binocular tube, monocular tube for photomicrography, and fitted case.—*E. Leitz, Inc., 304 Hudson St., New York 13, N.Y.*

Mention No. 244 when filling out card.

FOR THE TESTING DEPARTMENT

Cold-test Cabinet

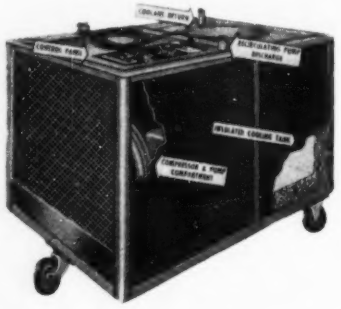
New "XV-70 Series" industrial chilling unit will hold any temperature from —10 to —70 deg. F.; has a thermal capacity of 500 Btu/hr. is avail-

able in chilling-chamber sizes from 5 down to 1.5 cu. ft. Largest chilling-chamber dimensions will be 30x18x16 in. deep. Chamber wall of 3/16 in. steel facilitates handling heavy or sharp-edged parts.—*Sub-Zero Products Co., 3930 Reading Rd., Cincinnati 29, Ohio.*

Mention No. 245 when filling out card.

Movable Refrigerating and Heating Systems

New "Junior Chil-er," movable self-contained refrigerating system for automatic recirculating of cold water or brine, is available in seven models,

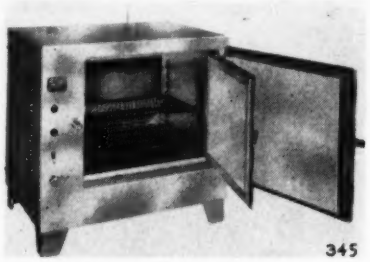


largest of which can pass through standard doorways. Compressor capacities from 0.25 to 3 hp.; pump capacities 1 to 10 gpm. Adjustable temperature ranges: with brine, —10 to +37 F.; with water, 38 to 60 F.; with heating element, 60 to 140 F.—*Mayer Refrigerating Engineers, Inc., Rutherford, N. J.*

Mention No. 246 when filling out card.

Temperature and Humidity Test Cabinets

New constant temperature and humidity cabinets, for all tests (A.S.T.M., etc.) involving 90-100 percent relative humidity at from 4 to 70 deg. C. dry-bulb temperature, feature a counterflow



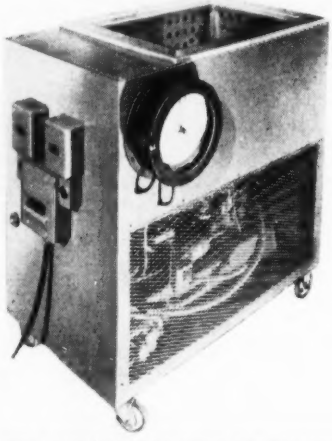
345

baffle which provides vigorous circulation, saves on cooling water when testing at temperatures below ambient, and maintains temperature uniformity. Thermostat has guaranteed response of plus or minus 0.5 C. Interior and exterior is stainless steel. Four standard chamber sizes from 1 to 9 cu. ft.; wattage consumptions 450 to 1250; all wiring complete and meets N.E.C. specs.—*Blue M Electric Co., 306-08 W. 69th St., Chicago 21, Ill.*

Mention No. 247 when filling out card.

Constant-temperature Bath

New constant-temperature bath maintains desired temperature within 0.25 deg. F., uses both a refrigeration system and an electric heating system.

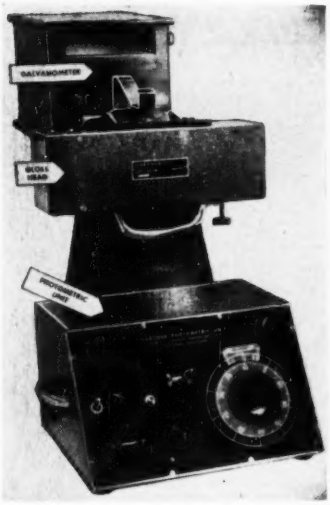


It was developed because temperature coefficient of expansion formula was not sufficiently accurate in dealing with 0.001-in. tolerances in cylindrical aluminum parts. With two of these baths —one at factory and one at point of acceptance—micrometering of parts is accomplished at exactly the same temperature.—*Service Metal Fabricators Co., 350 N. Foothill Rd., Beverly Hills, Calif.*

Mention No. 248 when filling out card.

Gloss-measuring Unit

New "Precision Glossmeter" comprises an electrical measurement unit ("Photometric Unit") and a number of exposure heads purchaseable individually, each of which contains a light source, means for directing light onto test specimens, and one or more bar-

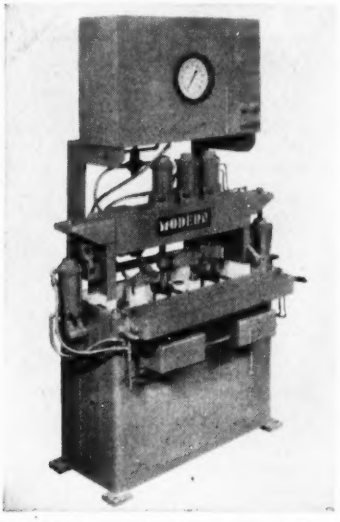


rier-layer photocells. Any number of exposure heads can be connected permanently to Photometric Unit and instantly switched on by means of multiple-switch stand. Five heads are available: for 20, 45, 60, 75 and 85 degrees, in compliance with ASTM and Federal specifications.—*Gardner Laboratory, Inc., Bethesda 14, Md.*

Mention No. 249 when filling out card.

Leak-test Machine

New pressure testing machine detects and locates leaks in gas passages in cast-iron automotive engine exhaust



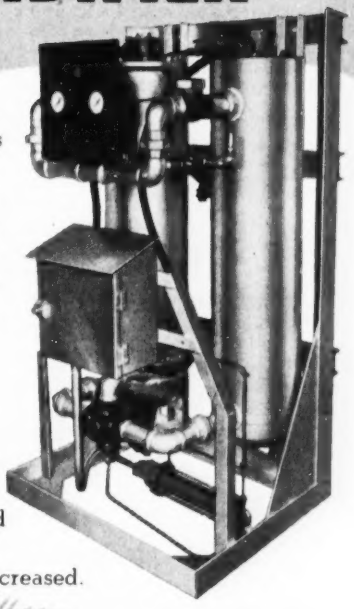
manifolds. In operation, manifolds are manually loaded into test area where exhaust gas areas are sealed by air-cylinder-controlled pads. An automatic air test cycle starts. Loss is indicated by a gage.—*Modern Industrial Engineering Co., 14230 Birwood, Detroit 4, Mich.*

Mention No. 250 when filling out card.

Universal Testing Machine

New floor-type 200,000-lb. universal testing machine permitting great working capacity on a finished machine pad bed of 4 x 15 feet is designed especially for specimens such as bridging mem-

Keep Instrument Air CLEAN and DRY with an Industrol DYNAMIC DEHUMIDIFIER



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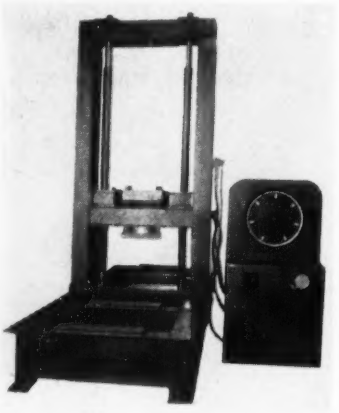

bers, aircraft wings, and concrete columns. Among unique features: Crosshead driven by a Thymotrol motor mounted directly on crosshead (instead of at bottom of machine), raised and lowered on fixed screws. Speed range of motor 20:1, providing an over-all loading speed of 0.025 to 0.5 in/min. and a high traverse speed of 15 in/min. Flexure plate construction in each plane allows eccentric loads to be used. Welded steel, fully stress-relieved, used throughout.—*Young Testing Machine Co., Skelton Building, Bryn Mawr, Penna.*

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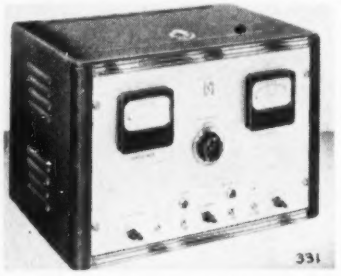
NUCLEONICS

Scintillation Count Rate Meter

New "Model CRM-500" scintillation count rate meter incorporates: (1) fast pulse amplifier with a rise time of 0.25



microseconds and a variable amplification up to 1500; (2) electronic discriminator which accepts pulses from —100 to +50 volts; (3) high-voltage supply variable from 500 to 1800 volts and regulated to 0.005 percent per one-volt change in line voltage between 95 and 100 volts.—*Nuclear Research & Development, Inc., 6425 Etzel Ave., St. Louis 14, Mo.*

Mention No. 252 when filling out card.

Scintillation Detector

New "Model DS-1" scintillation detector, designed for efficient gamma-ray counting in clinical and laboratory applications, is provided with a thallium-activated sodium iodide crystal and has a plateau length of approx. 200 volts. With external directional

shield in place, efficiencies of 33 percent or greater are obtainable using Cobalt 60, and 40 percent cr greater using Iodine 131. A built-in preamplifier provides an output pulse in excess of 0.25 volt, making its use possible at G-M input of any scaler or count-rate meter. It is available as a separate unit; or with a special lead shield for sample counting.—*Nuclear Instrument & Chemical Corp., 229 West Erie St., Chicago 10, Ill.*

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Radiation Monitor

New "Model 1800 Laboratory Monitor" is a general-purpose count rate meter with provision for visual and/or aural indication, selection of five

ranges: 300, 1000, 3,000 10,000 and 30,000 counts per minute, and aural volume control. Instrument may be obtained with a GM Tube and probe. Accuracy is approx. ±5 percent.—*Berkeley Scientific Div., Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif.*

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Centrifuge Tube for Radioactive Specimens

New "Atomlab-Ekstein Centrifuge Tube" is for collection of radioactive precipitates directly onto standard 1¼-in. diameter sample pans. Precipitate is deposited in a smooth, well-packed, and even-thickness layer, thus insuring necessary counting reproducibility. After centrifugation, sample pan is ready for

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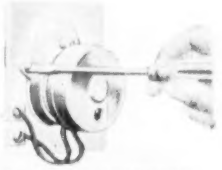
Means freedom from worry about mounting position, no limitations on your original design and field operation.



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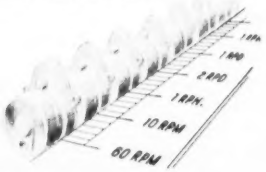

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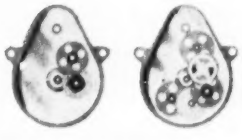

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FOR THE AMERICAN HELICOPTER CO., Mesa, Ariz.

THE PROBLEM: Determine the thrust of rotor tip-mounted pulse-jet engines under simulated flight conditions.

THE SETUP: A single, counterweighted, main rotor blade with pulse-jet unit is mounted on a test stand. A Chrysler industrial engine, geared to rotate the blade under test, is mounted on a cradle suspended from two points on the centerline of its own drive shaft.

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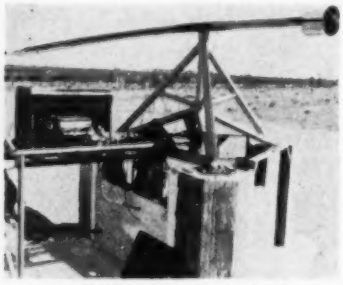
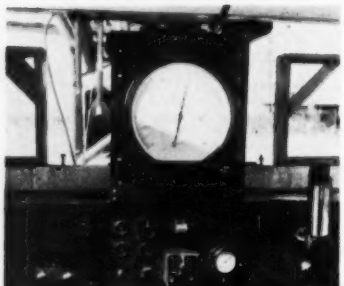


Pulse-Jet Rotor mounted on Test Stand



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NEW INSTRUMENTS

radioassay by usual counting arrangements. New tube (useful also for non-radioactive precipitates) comprises a stainless-steel cylindrical liner, standard sample pan held to bottom of liner by "O" ring seal and specially designed leakproof trunnion cup which fits directly onto standard 50-ml. clinical centrifuge head.—*Atomic Center for Instruments & Equipment, Inc., 489 Fifth Ave., New York City.*

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FOR INSTRUMENT SHOP

Snap Gages and Stand

New adjustable snap gages, for production and inspection checking, are available in a variety of sizes and ranges; also with special anvil devel-

oped according to specification or requirements. Stand is used while gage is being set and while parts are being inspected, so that possibility of body heat error is eliminated.—*H v H Tool & Instrument Co., 150 Lafayette St., New York 13, N. Y.*

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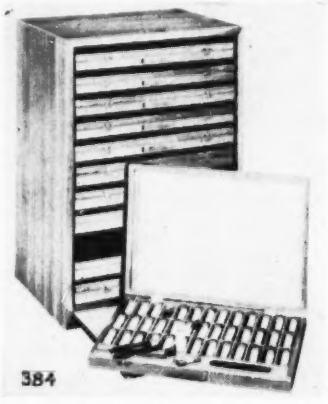
Gage-set Cabinets

New mahogany cabinets are available into which any of maker's gage sets will fit. Space is provided also for

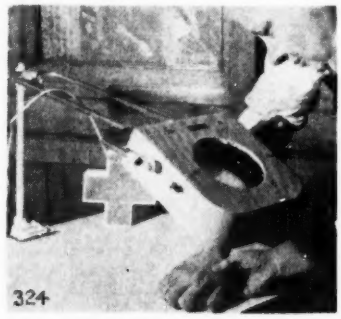


separate collets to fit a universal handle for each plug member in Class XX, X, Y and Z accuracies.—*Size Control Co., Div. American Gage & Machine Co. 2500 W. Washington Blvd., Chicago 12, Illinois.*

Mention No. 257 when filling out card.

Illuminated Magnifier

New "Model 203" fluorescent lighted magnifier has a 5 in. dia. double convex magnifying lens surrounded by a 22-

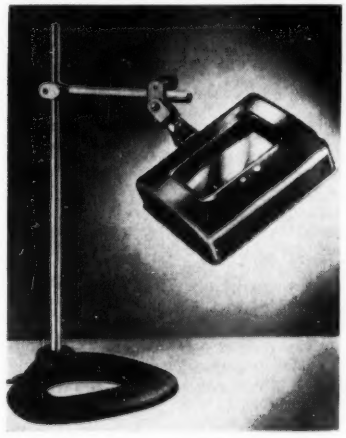


watt Circline fluorescent tube which eliminates shadow and is fully shielded from lens and user's eyes. A frosted plastic shield is mounted below fluorescent Circline tube to soften lighting. Unit is available as "Model 201" in maroon finish, without plastic shield and with a heavier duty bracket for industrial inspection uses.—*Larrimore Sales Co., P. O. Box* 1234, *St. Louis* 1, *Mo.*

Mention No. 258 when filling out card.

"White or Black Light" Magnifier

New "No. 1927 Unit" features white or "black" light, plus 3× magnification. For inspection, twin fluorescent white lights provide cool, glare-free illumina-



tion. Interchangeable twin "black-light" tubes provide fluorescent response to reveal excess rosin or flux on soldered areas; extent or lack of coverage by varnishes or fungicidal coatings; leaks of oil or wax from components, etc. For identification of parts, a new invisible stamping medium is available, as are fluorescent tracers for all types of materials.—*Burton Mfg. Co.,* 11201 *W. Pico Blvd, Los Angeles* 64, *Calif.*

Mention No. 259 when filling out card.

Air Gages for Jet Blades

Two new gages speed checking of external and internal pitch diameters of root forms on jet engine blades and blade carriers. Both are used as hand gages in conjunction with a standard

The Simple and Economical...

S14-C OSCILLOGRAPH
is an essential in every laboratory
6 or 12 elements

For general laboratory use in industry and in colleges, for testing and research everywhere, the New S14-C Economy Oscillograph is doing the job.

This versatile high-quality oscillograph is opening up new and wide fields for oscillography because it is so easy to use and because its cost is so low. Attachments of many kinds are available for every possible need.

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Daylight loading and unloading
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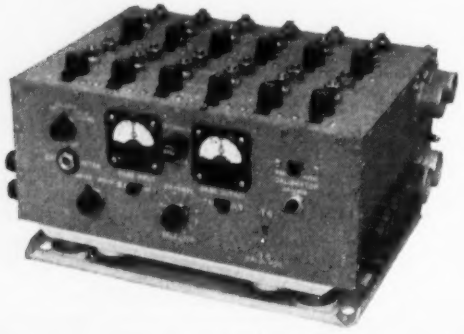
Century MODEL 1809 BRIDGE CONTROL UNIT

FOR VIBRATION AND STRESS ANALYSIS



Designed as a companion unit to Century's famous Model 409 Oscillograph, the Model 1809 Bridge Control Unit is the latest addition to Century's line of industry-standard vibration and stress analyzing equipment. Packaged in a small, compact space, the unit contains all of the facilities necessary for use with 12 channels of resistance strain gages or bridge-type transducers. Where used with the Model 409 Oscillograph, it is necessary only to connect strain gages and power source to have a complete stress-strain measuring and recording system, small and rugged enough to be placed in an aircraft wing tip or guided missile warhead.

FEATURES:

Size: 4½" x 7" x 11".

Weight: 10½ pounds.

Aluminum case.

Up to 12 channels.

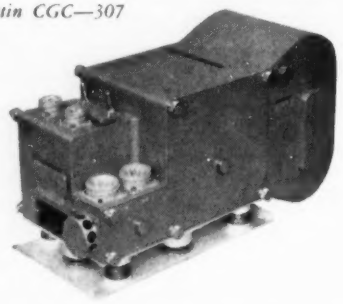
For any resistance strain gage or bridge-type transducer.

May be used with direct indicating instrument.

Power: Control unit, 22-28 Volt D.C.
Strain gage, 6-28 Volt D.C.

Write for Bulletin CGC—307

MODEL 409 OSCILLOGRAPH



The Century Model 409 Oscillograph has been designed for recording data where space and weight requirements are limited. The Oscillograph has been tested to record faithfully while subjected to accelerations up to 20 G's.

FEATURES:

Size: 5" x 6 15/16" x 11 15/16".

Weight: 13 pounds.

Cast aluminum case.

Paper speeds variable ½" to 6" and 2" to 24" per second.

Detachable daylight loading magazine with a capacity of 3⅝" x 100' paper.

2 to 14 individual channels.

Trace identification.

Trace viewing.

Write for Bulletin CGC—303

Century GEOPHYSICAL CORPORATION
TULSA, OKLAHOMA

4447 No. Bodine, Philadelphia 40, Pa. — 3406 W. Washington Blvd., Los Angeles 18, Calif. — 238 Lafayette St., Dayton 2, Ohio — 309 Browder St., Dallas, Texas — EXPORT OFFICE 149 Broadway, N. Y. City

NEW INSTRUMENTS

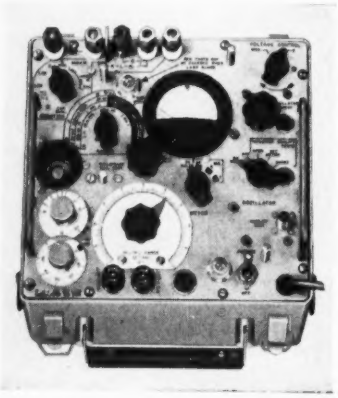
P&W "Air-O-Limit Model F" comparator. Blade root gage has an adjustable carbide roll-type anvil, a carbide ball point spindle which operates air nozzle, and a carbide roll pressure shoe which spans gage point and provides positive location of gage on blade root. Carrier gage has a carbide roll-type anvil, and carbide gaging roll on a pivot arm which operates air nozzle.—*Pratt & Whitney, Div. Niles-Bement-Pond Co., West Hartford 1, Conn.*

Mention No. 260 when filling out card.

ELECTRICAL INSTRUMENTS

Capacitance-Resistance-Inductance Bridge

New "Model 712" capacitance-resistance-inductance bridge measures capacitance of paper, mica, electrolytic, ceramic and air capacitors; stray capacitance of bushings, switches and wiring; dissipation factor of capacitances; leakage current of electrolytic capacitors; resistance of composition and wire-wound resistors; inductances of coils and transformers; storage factor (Q) of inductances; turns ratio of transformers; insulation resistance of capacitors, bushings and barriers; and quality of capacitors already wired into a circuit.—*Dep't I, Clough-Brengle Co., 6024 Broadway, Chicago 40, Ill.*



Mention No. 261 when filling out card.

Modulation Monitor

New "MD-33" frequency modulation monitor checks modulation swing of FM transmitters operating in Police, Fire and Special Service bands from 25 to 174 Mc. Continuous coverage is accomplished in two bands without use

326

of plug-in units. Modulation swing is indicated directly on a four-inch 20-kc. scale linear calibration. A dual range flasher circuit permits checking overmodulation by shortest of voice peaks at either of two pre-set amounts of swing.—*Browning Laboratories, Inc., 750 Main Street, Winchester, Mass.*

Mention No. 262 when filling out card.

D-c. Indicating Instrument with Servo-driven Pointer

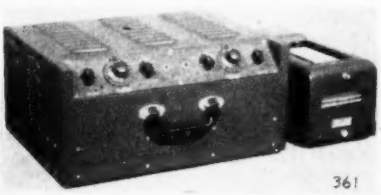
New "Tektolog" electrical indicator is available as an industrial indicator or as a table model for use in lecture halls or demonstration rooms. With a frontal area of 15 x 16 in. and an effective scale length of 11 in., it is clearly readable at 40 to 50 feet. Measuring

element is a moving-coil movement adapted to maker's capacity follower system; pointer is servo-driven and absorbs no power from movement. Full-scale travel is approx. 1.5 sec. Full-scale deflection with 50 microamp, 200 microamp and 1 milliamp d.c. currently available; other sensitivities to special order.—*Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. 4th St., Philadelphia 33, Pa.*

Mention No. 263 when filling out card.

Recorder Amplifier

New "Model R3 Recorder Amplifier," developed as a part of "GEDA" computer equipment but usable also with other electronic equipment, is a portable unit designed especially to plot solutions to small problems where use of a large recorder would be impractical. It works with standard direct-inking or hot-wire recording galvanometers. Its accuracy is limited only by nonlinearities of galvanometer-recorders. Typical units are guaranteed to be within 2 to 5 percent. "R3" records two channels of information within a frequency range essentially flat from d.c. to 100 cps. Amplifier unit supplies its own power and has its own voltage reg-



Dickson pens the temperature-

Product of
Dickson Company
Chicago 19, Illinois

THE Dickson multi-range Minicorder Type 1A is designed to draw a continuous chart record of the exact surrounding temperatures. With this multi-range recorder, extremely accurate recordings can be made of the temperatures in deepfreeze compartments, standard refrigerators, general air conditioning and other temperature controlled areas. The compact Minicorder measuring element is a specially designed spiral coil of Chace Thermostatic Bimetal calibrated to move a pen across the chart with a temperature change of 45°.

The precision-wound coil is fixed to the outer end of the mounting on the back of the dial. A pen with an extended arm is attached to a shaft that is spot welded to the inner end of the coil. Changes in room temperature cause the element to react in a coiling or uncoiling motion, thus causing the pen to move left or right, recording the temperature. At the same time a spring wound clock rotates the chart to synchronize the time with the temperature reading.

The accuracy of this multi-range recorder is dependent upon precision manufacturing and assembly methods. We fabricate this type of coil from precision-rolled strip stock in a controlled-temperature department. We also provide our 29 types of thermostatic bimetal in elements to customer design, in strips, random coiled lengths or welded or brazed sub-assemblies. Before proceeding with your next design, consult our Application Engineers or write for our 32-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing condensed engineering data.

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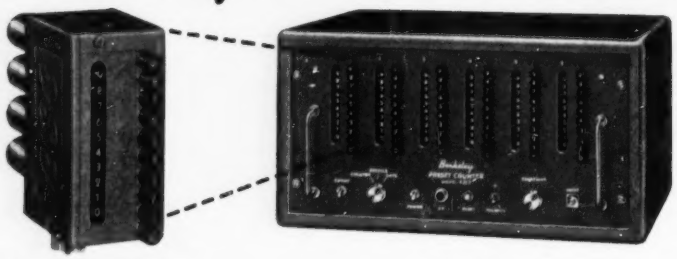
Now...

COUNTING

PLUS CONTROL

AT RATES TO 40,000 CPS WITH

***Berkeley* PRESET COUNTERS**



DESCRIPTION—The Berkeley Preset Counter is an electronic decade with provisions for producing an output signal or pulse at any desired preset count within the unit's capacity. Any physical, electrical, mechanical or optical events that can be converted into changing voltages can be counted, at rates from 1 to 40,000 counts per second. Total count is displayed in direct-reading digital form. Presetting is accomplished by depressing pushbuttons corresponding to the desired digit in each column. Model 730 Preset Decimal Counting Units are used. These are completely interchangeable plug-in units designed for simplicity of maintenance and replacement.

APPLICATIONS—Flexibility and simplicity of operation make the Berkeley Preset Counter suitable for both production line and laboratory use. It has practical applications wherever signalling or control, based on occurrence of a predetermined number of events or increments of time is desired. Output signals from the unit can be used to actuate virtually any type of process control device, or to provide aural or visual signals.

SPECIFICATIONS	Model				
	422	423	424	425	426
MAX. COUNT CAPACITY	100	1000	10,000	100,000	1,000,000
INPUT SENSITIVITY (MIN.)	± 1 v. to ground, peak; at least 2 μ sec. wide				
OUTPUT	Choice of pos. pulse and relay closure, or pos. pulse. SPST relay closure approx. 1/30 sec; pulse output is + 125 v. with 3 μ sec. rise time and 15 μ sec. duration.				
PANEL DIMENSIONS	15⅛" x 8¾"		19" x 8¾"		
OVERALL DIMENSIONS	16⅝" x 10¼" x 13"		20¼" x 10½" x 15"		
POWER REQUIREMENTS	117 v. ± 10% @ 90w.		117 v. ± 10% @ 180 w.		
PRICE (F.O.B. FACTORY)	$375	$450	$595	$695	$795

M3 *For complete information, please request Bulletin 602*

Berkeley Scientific

division of BECKMAN INSTRUMENTS INC.

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"DIRECT READING DIGITAL PRESENTATION OF INFORMATION"

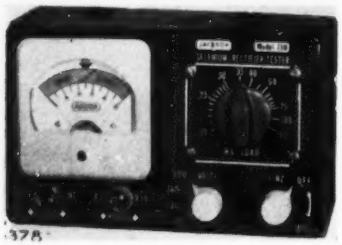
NEW INSTRUMENTS

ulator. Amplifier channels have input impedance of 2.5 megohms on 0.01 to 0.1 volt-per-millimeter range and greater than 10 megohms on all other ranges. Limiting circuits in amplifier protect galvanometer-recorder movements and keep pens in their pivots when an overload is applied.—*Goodyear Aircraft Corp., Akron 15, Ohio.*

Mention No. 264 when filling out card.

Selenium Rectifier Tester

New "Model 710," for testing all radio and television selenium rectifiers rated from 20 to 650 ma., operates on 110 to 125 volts a.c. and has a variable

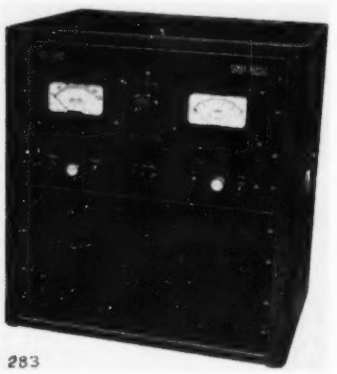


indicated voltage range of 25 to 300 volts a.c. Use is said to be extremely simple. After load and volt indicators are set and line voltage adjusted, test lead clips are placed on rectifier terminals, correct range is selected and test switch is pressed. Then dial shows condition of rectifier and also indicates life expectancy.—*Jackson Electrical Instrument Co., 20-48 S. Patterson Blvd., Dayton 2, Ohio.*

Mention No. 265 when filling out card.

Regulated D-c. Power Supplies

New "700 Series" voltage-regulated power supplies feature regulated direct voltage with excellent regulation, low ripple content and low output im-

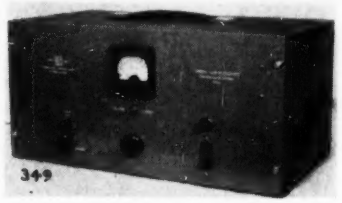


pedance. "Model 700" delivers 0 to 0.75 amp.; "Models 710, 720 and 730" deliver 1.5, 2.25 and 3.0 amps. respectively. High-voltage supply is continuously variable from 0 to 350 volts. Four other units supply 0.600 volts continuously variable: Models 750, 760, 770 and 780 deliver 0.75, 1.5, 2.25 and 3.0 amps. respectively. In all eight units, ripple is less than 10 mv. peak-to-peak.—*Kepco Laboratories, 131-38 Sanford Ave., Flushing, N. Y.*

Mention No. 266 when filling out card.

Low-voltage Power Supply

New "Type 200" low-voltage power supply is a highly regulated unit for use with resistance strain-gage elements and for similar exacting applications. Output is one ampere maximum, at



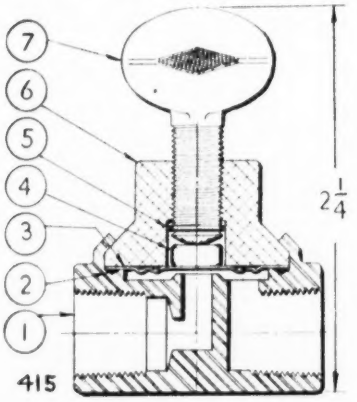
zero to 15 volts d.c. Where absolute freedom from drift is required, a small chopper-amplifier provides precise stabilization against an external reference. New supply may be rack-mounted. —*Owen Laboratories, 9130 Orion Ave., San Fernando, Calif.*

Mention No. 267 when filling out card.

VALVES

Small Packless Valves

New "Model Demi-G" is a packless tamper-proof globe valve for hydraulic, pneumatic, or vacuum service with pressures up to 1500 psi. in brass and aluminum (higher pressures in other



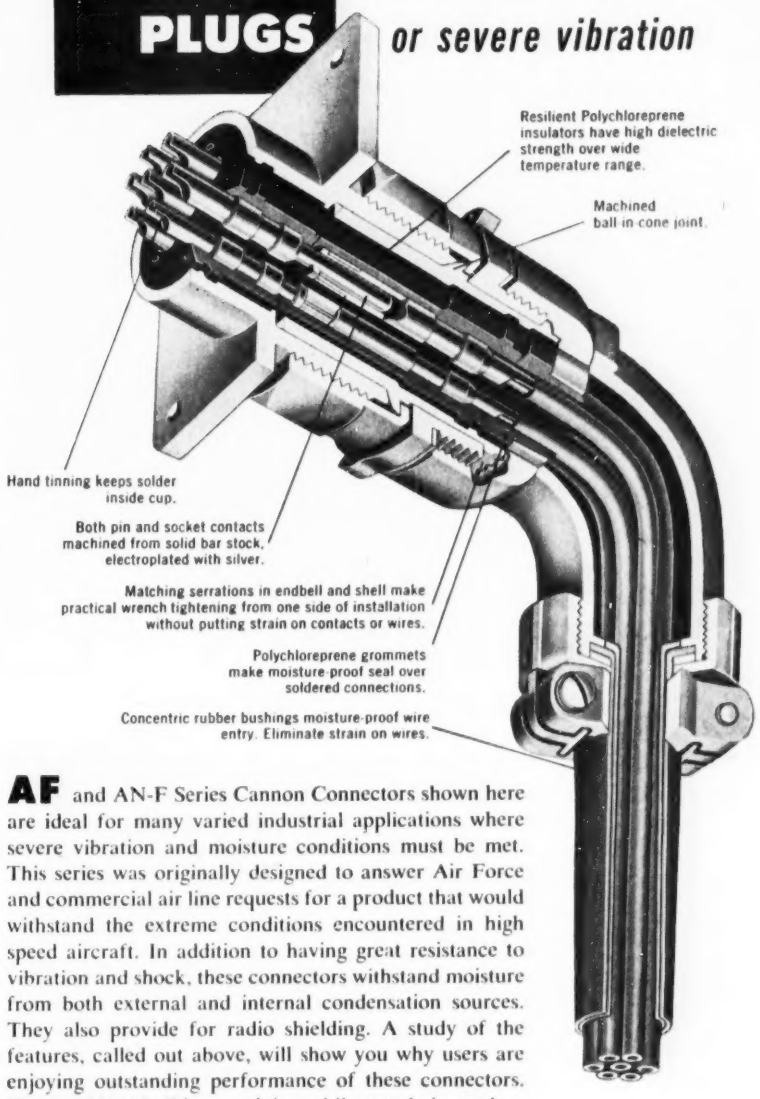
materials), for oil, water, gas and corrosive systems. Body (1) is manufactured from bar stock. Diaphragm (3) is sealed in place between bonnet (6) and gasket (2) and retained by swaging. Valve is operated by actuator (7) thrusting button (4) against diaphragm (3) which seals inlet port. Standard size has maximum ¼ in. IPS or ¼ in. integral tubing connections.—*George W. Dahl Co., Inc., Bristol, R. I.*

Mention No. 268 when filling out card.

Pressure Relief Valve

New pressure relief valve of cartridge type, insensitive to back pressure or system pressure, operates in such manner that it is not a bias across the line. Relief pressure stays constant over a wide range of back pressure. New valve is a modification of maker's relief valve (built under MIL-V-5523 specs) which is standard equipment

CANNON PLUGS *to withstand moisture or severe vibration*


Resilient Polychloreprene insulators have high dielectric strength over wide temperature range.
Machined ball-in-cone joint.
Hand tinning keeps solder inside cup.
Both pin and socket contacts machined from solid bar stock, electroplated with silver.
Matching serrations in endbell and shell make practical wrench tightening from one side of installation without putting strain on contacts or wires.
Polychloreprene grommets make moisture-proof seal over soldered connections.
Concentric rubber bushings moisture-proof wire entry. Eliminate strain on wires.

AF and AN-F Series Cannon Connectors shown here are ideal for many varied industrial applications where severe vibration and moisture conditions must be met. This series was originally designed to answer Air Force and commercial air line requests for a product that would withstand the extreme conditions encountered in high speed aircraft. In addition to having great resistance to vibration and shock, these connectors withstand moisture from both external and internal condensation sources. They also provide for radio shielding. A study of the features, called out above, will show you why users are enjoying outstanding performance of these connectors. The machined ball-in-cone joint, while not obvious, plays an important part in providing radio shielding and improved vibration and moisture resistance. For engineering data request Cannon's AN Bulletin.

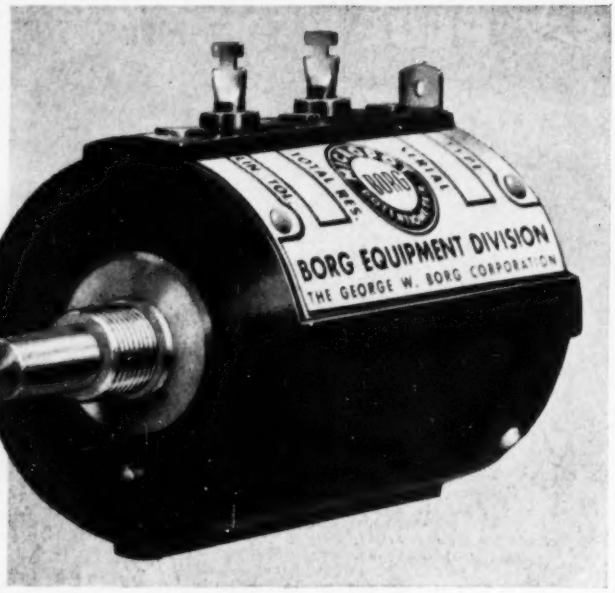
The Cannon AF Series consists of 2 plug types and 3 receptacles in 15 diameters. Contact arrangements closely follow those in the AN Series. Shells are cadmium plated. The sturdy hex shaped coupling nut shown here is used on sizes 8S through 18. Larger diameters have a strong spline type coupling nut to fit spanner wrenches. Knurled type coupling nuts are available to meet AN-F specification.

CANNON ELECTRIC

Since 1915

Factories in Los Angeles, Toronto, New Haven, Benton Harbor. Representatives in principal cities. Address inquiries to Cannon Electric Company, Dept **B-180** P.O. Box 75, Lincoln Heights Station, Los Angeles 31, Calif.

THE HIGH-PRECISION LINEAR POTENTIOMETER

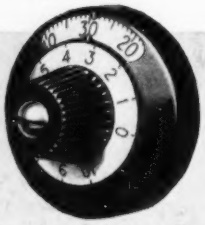


MICROPOT
precision ten-turn potentiometer

BORG MICROPOT TEN-TURN POTENTIOMETER: Built to fit the specifications of control system engineers and designers . . . constructed with Micro accuracy for precise voltage adjustments . . . featuring an assembly scientifically designed, machined, assembled and automatically machine tested for linearity of ±0.1% and 0.05%, zero-based. MICROPOTS ARE AVAILABLE IN 1.15 to 3 OHM and 30 to 250,000 OHM RANGES FOR IMMEDIATE SHIPMENT.

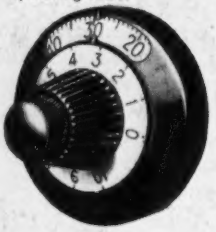
BORG MICRODIAL: Two concentrically mounted dials: one for counting increments of each turn and the other for counting turns . . . delivered completely assembled with dials synchronized. Outstanding features include smooth, uniform action . . . no backlash between incremental dial and potentiometer contact . . . less wear, only one moving part aside from the two dials . . . contact position indicated to an indexed accuracy of 1 part in 1,000.

MICROPOT—MICRODIAL CATALOG SENT PROMPTLY ON REQUEST



BORG MICRODIAL 746-A

A precision ten-turn indicating dial assembly. Has screw locking device on operating knob.



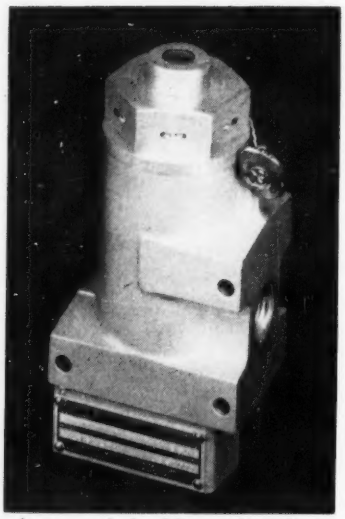
BORG MICRODIAL 746-B

Same as 746-A but has knurled locking screw mounted externally to operating knob.

MICRODIAL MICROPOT BORG

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
Janesville • Wisconsin

NEW INSTRUMENTS



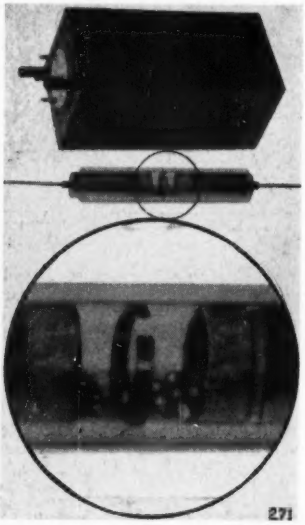
in planes made by fifteen aircraft manufacturers.—*Hydraulics Div., Pantex Mfg. Co., Pawtucket, R. I.*

Mention No. 269 when filling out card.

ELECTROMECHANICAL COMPONENTS

Shock-proof Ball Relay

New shock-proof hermetically-sealed relay capable of operating at extremely high speeds (over 100 operations per second) is for use on d.c. circuits. Unusual feature is use of magnetic balls



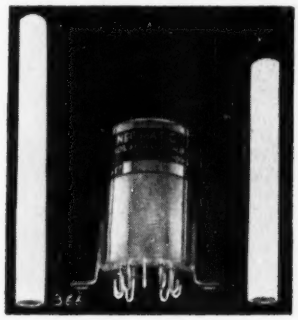
as contact medium providing new contact surfaces on each operation and preventing misoperation under vibration in aircraft and automobiles. A special non-magnetic plating on balls and pole-pieces provides long-life contact; avoids sticking caused by current interruption; prevents contact holding due to residual magnetism. Pole pieces are insulated from each other and are terminals of circuit to be closed. Upon deenergizing, balls release and fall to

one side of chamber and interrupt circuit. Proportions of pole-pieces and chamber, and number of balls, will not permit bridging between terminals even with violent shaking of relay, regardless of its attitude.—*Magnex Corp., 90-28 Van Wyck Expressway, Jamaica, N. Y.*

Mention No. 270 when filling out card.

Subminiature A-c. Relay

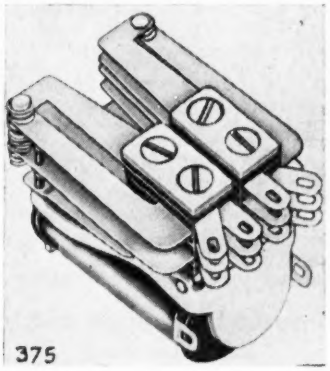
New d-p.d-t sealed a-c. 50-500-cycle relay is available for immediate delivery. Features include hermetic sealing with dry air or inert gas, subminiature size, light weight, resistance to vibration, and continued operation under high accelerations. Two models: "10220" has a contact rating of 1 amp, non-inductive; "10320" has a contact rating of 4 amps, non-inductive.—*Neomatic, Inc., 9010 Bellanca Ave., Los Angeles 45, Calif.*



Mention No. 271 when filling out card.

Telephone Type Relays

New "MJ Series" miniature telephone type relays, available open or hermetically sealed, features longer, more flexible contact arms than previous series, resulting in a lower spring load rate, wider contact gap, more overtravel, improvement in sensitivity, faster action and longer life. Available with a maximum of four Form C contacts for either d.c. or 60-cps. a.c., maximum coil resistance 22,000 ohms.—*Potter & Brumfield, Princeton, Indiana.*



Mention No. 272 when filling out card.

Motor-cutout Switch for Recording Potentiometers

New automatic motor cut-out mercury switch permits faster, safer instrument servicing of strip-chart "Tel-O-Set" recorders: live power line to chart motor is instantly and auto-

Stuck without WARNING

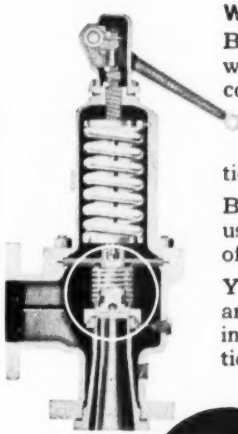
Who's stuck?

Safety valves that weren't safe? The plant which installed them?

None of this was necessary. If you want 100% safety—and you'd hardly want less—there's one sure way to get it—specify BalanSeal or FarriSeal Valves.

Why?

Because they *can't* stick, plug or corrode. Critical working parts are permanently isolated from any contact whatever with the lading.



Because they're unaffected by back pressures in the discharge manifold due to its own operation or to the opening of other valves in the line.

Because these features make it possible for you to use smaller discharge piping, an economy which is often substantially more than valve cost.

You'll be interested in the engineering of BalanSeal and FarriSeal Valves—design which is rapidly gaining acceptance in hundreds of successful installations.

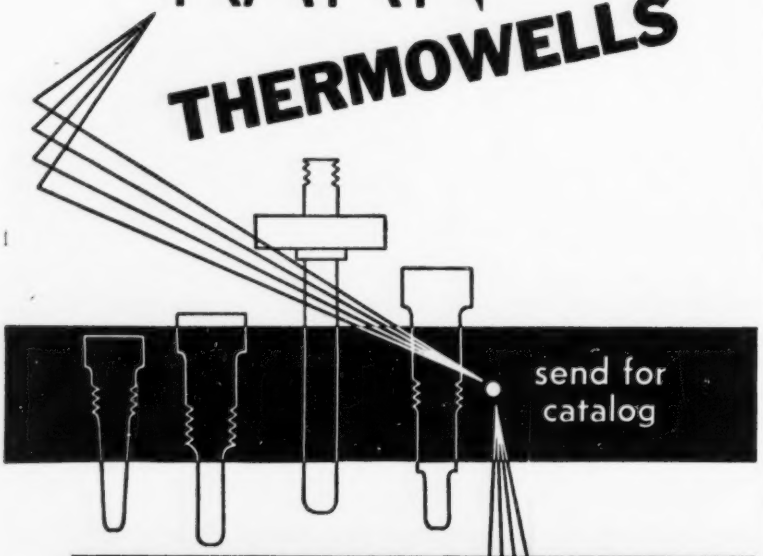
Ask for our "8-Minute Brief."

Your Safety's REAL With FarriSeal

Farris ENGINEERING CORP.

610 COMMERCIAL AVE., PALISADES PARK, N. J.

KARN
THERMOWELLS



KARN · CHEMICAL · EQUIPMENT · COMPANY
518 DICKSON AVENUE · PITTSBURGH 2, PA.

Which butterfly valve better meets your needs?

In either of these or any other valves, manual or automatic, which W. S. Rockwell builds for your exact needs, you're sure to get the right type and size to best meet the conditions of operating pressure, temperature and nature of fluid handled, whether it be air, gases, water, liquid or semi-solid chemical materials.

It will pay you to learn how Rockwell Valves can meet your plant's flow control requirements.

Rockwell stainless steel valve; with air cylinder operator and valve positioner; for throttling gases at 1200° F.

Rockwell heavy duty valve for 50 p.s.i. working pressure; has a replaceable rubber liner for valve body and stainless steel blade; with a motor operator and handwheel declutching unit.

ROCKWELL Valves

Write for Valve Catalog

W. S. ROCKWELL COMPANY

BUTTERFLY VALVES • SLIDE VALVES • AUTOMATIC VALVES

2643 Eliot Street • Fairfield, Conn.

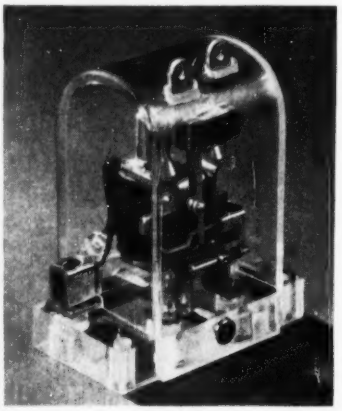
NEW INSTRUMENTS

matically de-energized when chassis is withdrawn beyond safety catch. There is no danger of accidentally shorting disconnected leads dangling against instrument case.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

Mention No. 273 when filling out card.

Overload Relay

New "Type C Silic-O-Netic Relay" can be furnished with time delay curves to match characteristics of protected equipment. However, since it provides a definite high-speed response point at eight times rating, it fills need for protecting hermetically-sealed motors, electronic circuits and control systems (ap-

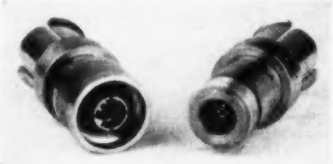


plications requiring fast protection at relatively low overload values). Principle: A brass tube, filled with silicone liquid, extends through and beyond solenoid coil and holds a movable iron core. On starting inrush or small overloads, magnetic force is not sufficient to attract armature but draws core into field at a rate controlled by viscosity of silicones. When core reaches polepiece, relay responds, providing delayed response. On large overloads, core is not a factor and relay operation is instantaneous. Units are insulated for 440-volt service. Coil ratings from 1 to 100 amperes. Over-all weight 6 oz.—*Heinemann Electric Co., 305 Plum St., Trenton 2, N. J.*

Mention No. 274 when filling out card.

Coaxial Adaptors and Accessories

New adaptors are available to connect from maker's "Type 874 Coaxial Connectors" to either male or female of Types N, C, BNC or UHF high-frequency connectors. They have excellent characteristics with a low VSWR even at several thousand megacycles. A new adjustable line, "Type 874-LK," for use in measurement work requiring a section of coaxial line of adjustable

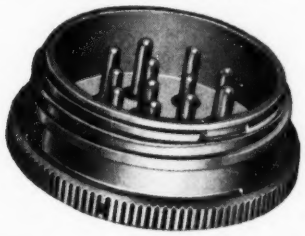


length but with uniform impedance, is a 50-ohm line adjustable from 58 to 80 cm. A shielded component mount has also been added to "Type 874" line to facilitate accurate measurement of resistors, capacitors, and inductors.—*General Radio Co., Cambridge 39, Mass.*

Mention No. 275 when filling out card.

Hermetically-sealed Connectors

New "KH" and "RKH" series of hermetically-sealed plugs and receptacles are similar in construction to "GS02" and "GS06" (AN type). "KH"



connectors will withstand 200 to 900 psi, depending on size and contact complement. Temperature operating range varies from —320 F. to 600 F., emergencies to 1,000 F. if mating fitting and finish are expendable. All MIL-C-5015 vibration and thermal shock tests are met.—*Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.*

Mention No. 276 when filling out card.

ELECTRICAL AND ELECTRONIC COMPONENTS

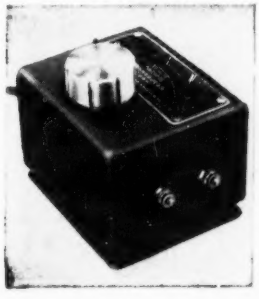
Sealed Resistors

New complete line of precision wirewound resistors, in accordance with JAN-R-93, Characteristic A, are hermetically-sealed in ceramic for extremely stable performance under wide temperature variations and total salt water immersion. Maker's hermetic sealing process physically isolates internal resistance winding from outside terminal.—*Shallcross Mfg. Co., Collingdale, Pa.*

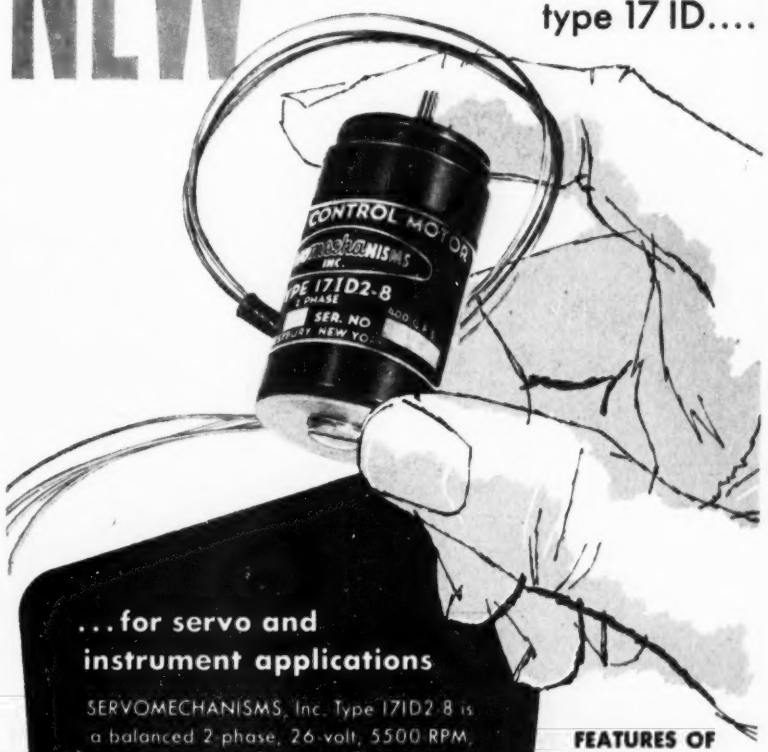
Mention No. 277 when filling out card.

Variable Transformer

New "Model 226" is a small variable transformer for portable use in factory and laboratory. It weighs 3 lbs. With a primary of 117 volts, 50 watts, secondary is from 7 to 13 volts continuously variable and 4 amperes continuous duty. It can be used for 6- to 12-volt lamps, small motors, heater elements and for operation of a-c. relays and solenoids. It will stand high overloads, which



NEW miniature damped control motor type 17 ID....



...for servo and instrument applications

SERVOMECHANISMS, Inc. Type 17ID2-8 is a balanced 2-phase, 26-volt, 5500 RPM, 400-cycle damped induction motor employing a drag cup and an axially adjustable magnet to achieve velocity damping. This design provides for variable and smooth linear velocity damping and lower operating temperature. The desired degree of viscous damping is achieved by operating setscrew adjustment.

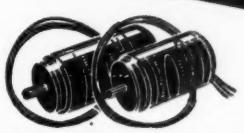
* * *

The non-damped induction control motor 17I2-8 of 8,000 RPM is also available.

FEATURES OF DAMPED CONSTRUCTION DESIGN INCLUDE

- Cogless Damping
- Zero Residual Noise Signal
- Constant Damping
- Lower Inertia
- Lower Cost

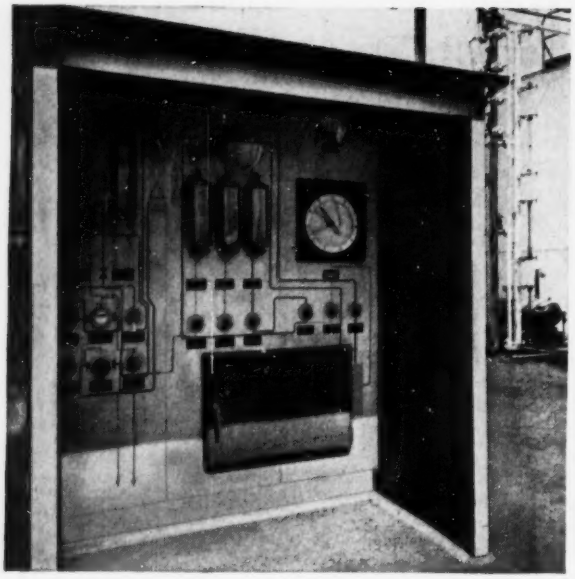
Write to Dept.-CLO-3 for specific information on motors.



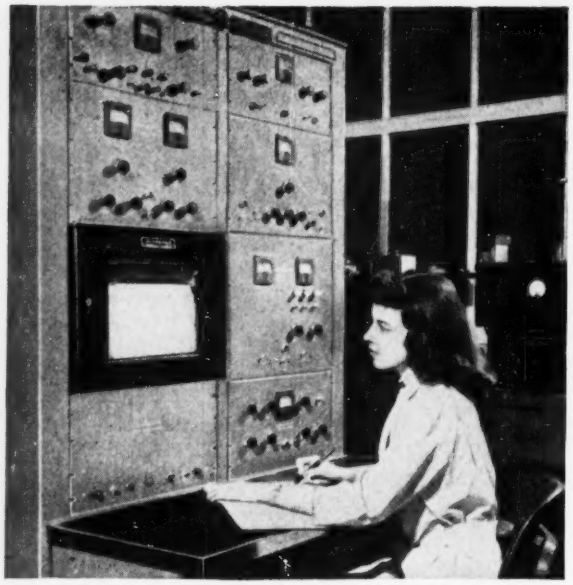
OTHER INSTRUMENT MOTORS

..... Hysteresis Synchronous design, Type 17HI-8 for 26 volts and Type 19H for 115 volts in speeds of 8,000, 12,000, and 24,000 RPM are available for various applications. Special windings and external shaft configuration can be provided on request.

SERVOmechaNISMS INC.
WESTBURY, L. I., N. Y.
EL SEGUNDO, CAL. NEW CASSEL, N. Y.



infra-red analysis *tells how much of a selected component exists in gas mixtures. Here, continuous analysis recorded by an* ***ElectroniK*** *potentiometer on a refinery's graphic panel is used for actual process control.*



mass spectrometry *separates materials on the basis of their different molecular weights . . . finds what constituents are present in what quantity. Above is a "package" mass spectrometer in which an* ***ElectroniK*** *instrument records test data.*

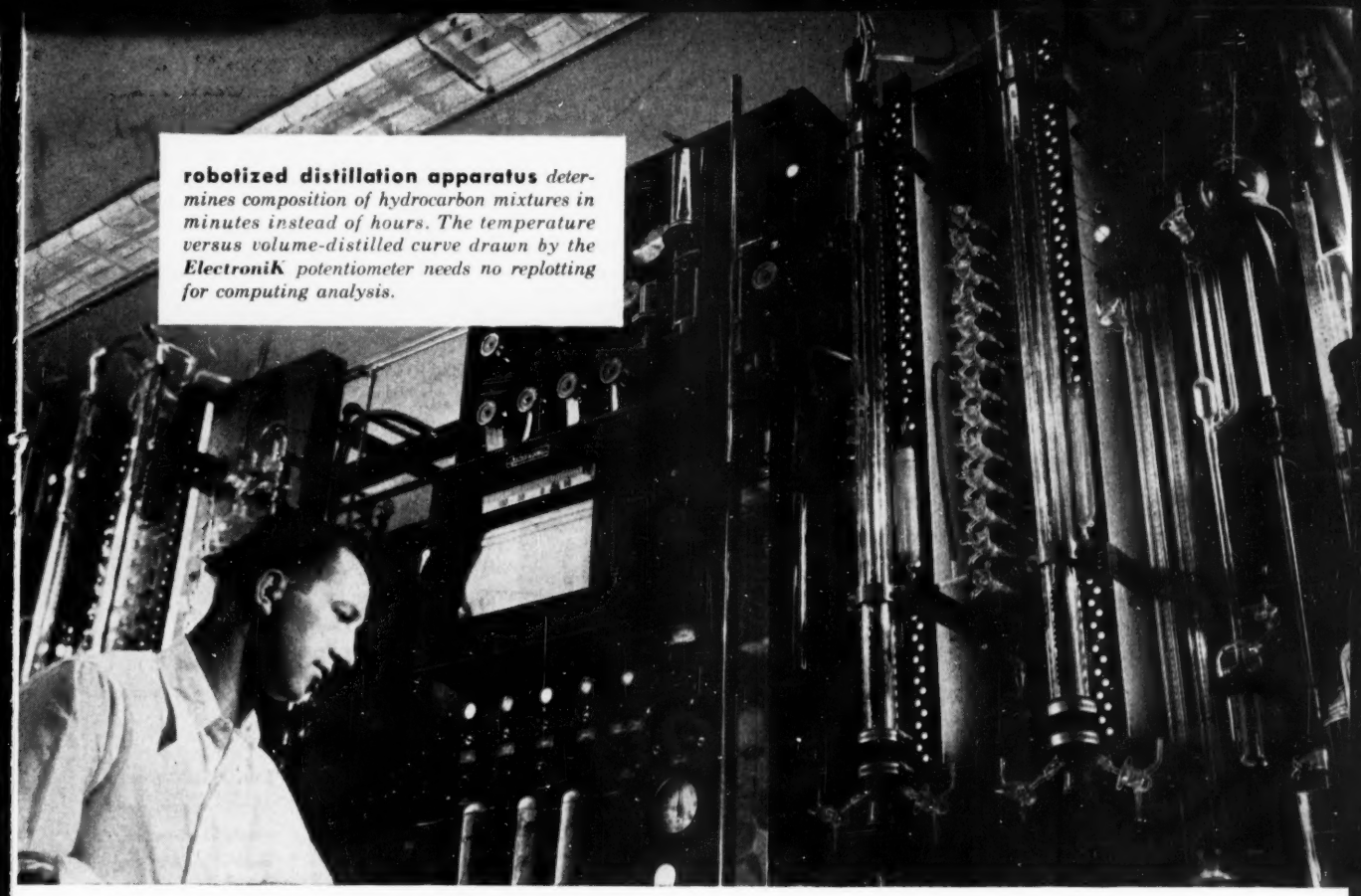
gas analyzer, *operating on the thermal conductivity principle, combines an* ***ElectroniK*** *recorder, analysis cell and accessories in a single panel assembly.*

New concepts *utilize*

These are some of the manufacturers who use *ElectroniK* instruments in their analyzers

Products of the companies checked are illustrated on these pages

Applied Research Laboratories
√ Baird Associates
Bausch and Lomb
Beckman Instruments, Inc.
Consolidated Engineering Corporation
√ Davis Emergency Equipment Co.
√ General Electric Co.
Jarell-Ash
Mine Safety Appliances Co.
North American Philips Co., Inc.
Perkin-Elmer Corp.
√ Podbielniak, Inc.
Precision Scientific Co.
E. H. Sargent & Co.
Tracer Laboratories
Turner-Burrell Technical Supply Co.



robotized distillation apparatus *determines composition of hydrocarbon mixtures in minutes instead of hours. The temperature versus volume-distilled curve drawn by the* ***ElectroniK*** *potentiometer needs no replotting for computing analysis.*

# of process control

ElectroniK instruments

FROM the analytical laboratory comes a new concept of industrial process control, based directly on the desired chemical or physical characteristics of the product.

Continuous analyzers now make it possible to measure composition of gases and liquids accurately and automatically . . . to record this information . . . even to actuate automatic controls. Instead of temperature, pressure and flow, these new systems deal in terms of refractive index, density, ultraviolet and infrared spectra, radiation intensity and absorption.

An essential component of all these systems is automatic recording. To fill this critical function, leading manufacturers of automatic analyzers choose *ElectroniK* instruments. They choose them for their exceptional accuracy, that exploits fully the inherent precision of the new measuring techniques. They choose them, too, for sensitivity that records every essential change in readily readable detail. And they prefer *ElectroniK* recorders for their simple, rugged design that guarantees dependable service under any industrial conditions.

Your local Honeywell engineering representative will be glad to discuss the role of *ElectroniK* instruments in product-analysis systems . . . or in any conventional process control. Cail him today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4482 Wayne Ave., Philadelphia 44, Pa.

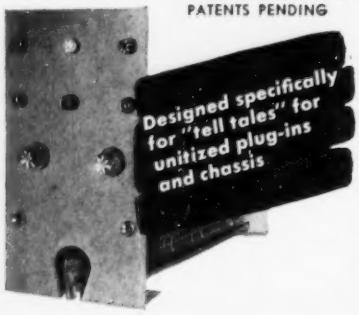
● **REFERENCE DATA: Write for Bulletin 15-14, "Instruments Accelerate Research."**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

From Alden's Line of Ready-made Components for Unitized Plug-in Unit Construction:

Miniature Sensing and Indicating Components by ALDEN

PATENTS PENDING



TOPS IN QUALITY & APPEARANCE
SAVE INSTALLATION COST & SPACE

ALDEN "PAN-i-LITE"

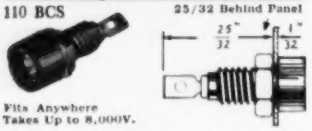
86L
Mounts in .348" hole
Quickly replace bulb from front of panel
Bulb and Lens are 1 pc. instantly replaceable with unbreakable spares.

You can use this new tiny Alden Pan-i-Lite indicator where never before possible. Easily serviced one-piece lens-bulb replaceable from front of panel. Mounts simply by pushing into .348" hole. Gives beautiful indication; glows like a red hot poker. Tiny spares can always be kept ready in kit or taped in recess of equipment. Available in 6V, 12V and 28V, various colors.

ALDEN "FUSELITE"

Spot trouble instantly. Neon indicator light in lens glows when fuse blows. One-piece molded lens-and-indicator-lite unscrews from front of panel. Ideal for monitoring power to each unitized circuit. Available for 28V, 110V and 250V.

ALDEN TEST POINT JACK



Provides a quick front panel check point for any circuit voltages in your equipment. This tiny Jack fits .257" hole and takes only 25/32" behind panel. Beryllium copper contact withstands hundreds of insertions. Phenolic or nylon insulation, many colors.

SEND FOR FREE SAMPLES

—also request free "Alden Handbook", 226 pages of techniques and components to help you design your equipment for Unitized Plug-in Unit Construction.

ALDEN PRODUCTS CO.

137 N. Main St., Brockton 64, Mass.

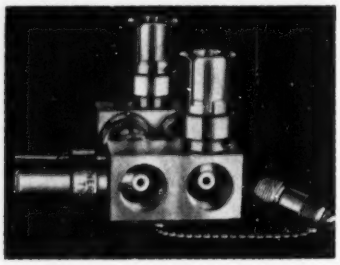
NEW INSTRUMENTS

makes it particularly valuable for experimental use.—*Pacific Transducer Corp.*, 11921 *W. Pico Blvd., Los Angeles* 64, *Calif.*

Mention No. 278 when filling out card.

Tunable Semi-artificial Half-wave Line

New "Type 874-UB Balun" permits making accurate measurements of balanced impedances in frequency range from 50 to 1000 Mc. Balun is a tunable

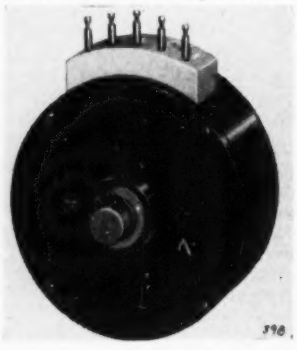


semi-artificial half-wave line, acts as a transformer, makes it possible to connect a balanced impedance to an unbalanced coaxial system as used on HF measuring instruments. Balun has two advantages over a conventional transformer:—it can be tuned over a wide frequency range and has low losses. Unbalanced end of balun is a "Type 874 Coaxial Connector," and thus it can be used directly with any of maker's measuring equipment.—*General Radio Co., Cambridge* 39, *Mass.*

Mention No. 279 when filling out card.

Potential-dividing Resistor

New "Universal Potentiometer Model 85196" with 1.75-in. diam. is available in single-section units with either synchro-type or screw-type mounting, in sleeve-bearing and ball-bearing models (0.5 oz.-in. torque for ball-bearing unit). Standard linearity tolerance is



0.3 percent; better linearity units available on special order. Mechanical rotation can be 360 deg. continuous, or stops can be provided for any rotation up to 330 deg. Resistances from 2,000 to 200,000 ohms are available with power dissipation of 3 watts at an ambient temperature of 25 C. Operating temperature range is from −54 to +71 C. and unit will function during 50 *G* acceleration applied along any axis. *G. M. Giannini & Co., Inc., P. O. Box N, Pasadena* 1, *Calif.*

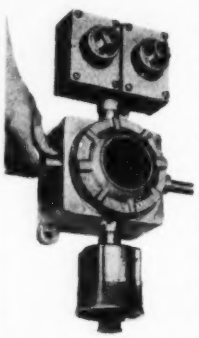
Mention No. 280 when filling out card.

DETECT combustible GAS

INDICATE • RECORD • CONTROL

MODEL F

J-W Model F Indicator checks the presence of combustible gas at inaccessible locations. Aspirator bulb draws air mixture through sampling hose and probe. Meter registers combustibility instantly. Fully portable, dry-cell operated.



MODEL EE

J-W Models E and EE Alarms monitor fixed installations where explosive hazards may exist. For continuous operation from standard 115-v a-c line. Actuate audible or visual signals, control valves or motors. Model EE is explosion proof. Model E is for installation remote from sensing unit.

SENTINEL

J-W Sentinel Alarm serves as a fire-danger watch-dog under conditions of special localized combustible-gas hazard—such as: welding, electrical work, tank cleaning, etc. Storage-battery operated, inbuilt charger, penetrating audible alarm.

Other models available for laboratory, oil-well logging, and other specialized uses. Your inquiry is invited on designs to meet particular requirements.

Standard for over 25 years

Write for complete information

JOHNSON-WILLIAMS, Ltd.

PALO ALTO 3, CALIFORNIA

Make Your Temperature CONTROL More EXACT

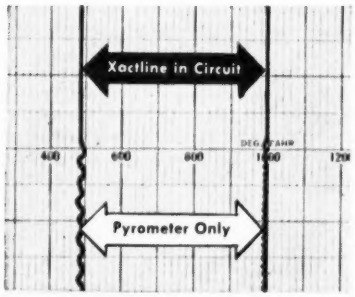
It's Easy with

XACTLINE

and it's automatic . . .

Your present indicating or recording pyrometer controls can be made to function more precisely—minimizing overshooting and undershooting—to meet the closest temperature-control requirement.

● Simply introducing the XACTLINE into the control circuit will give you this "Straight-Line" temperature control. It automatically anticipates temperature changes before they occur—producing a short on-off cycle. Unusually sensitive performance is due to the complete electric operation—no moving mechanical parts. No adjustment or coordination with the control instrument is necessary regardless of the size of the furnace—electric or fuel fired—length of the heating cycle, or size of the load.



Exact reproduction of temperature chart for a heating process showing the comparison of the "Straight-Line" temperature control produced by XACTLINE and the saw-tooth curve obtained with only conventional control.

PRICE **$89.50** F.O.B. CHICAGO

115 or 230 Volts, 60 Cycle.

Complete installation instructions. 4321

GORDON SERVICE

CLAUD S. GORDON CO.

Manufacturers • Engineers • Distributors

Metallurgical Testing Machines • Temperature Control Instruments • Thermocouples & Accessories • Industrial Furnaces & Ovens

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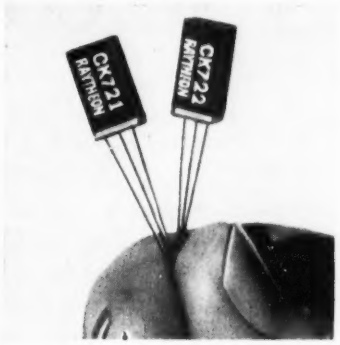
Dept. 21 • 2035 Hamilton Ave., Cleveland 14, Ohio

Junction Transitors

New "Types CK721 and CK722" are germanium transistors of the PNP type, with average power gains of 38 db and 30 db respectively. Both have

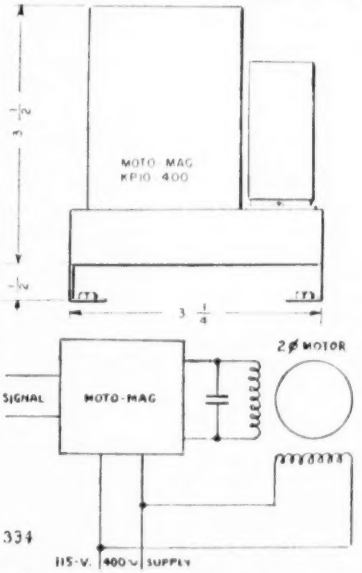


an average noise factor of 22 db at 1000 cps., a collector voltage of −1.5 volts and a collector current of −0.5 ma. @ 30 C. They have base currents of −6 and −20 microamps respectively. —*Receiving Tube Div., Raytheon Mfg. Co.*, 55 *Chapel St., Newton, Mass.*

Mention No. 281 when filling out card.

Magnetic Amplifiers

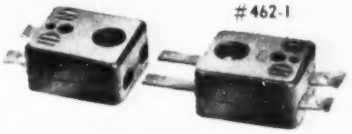
New "Moto-Mags" are said to represent a new development whereby engineers may select from a series of five magnetic amplifiers and fit their plans to these units instead of designing mag-



netic amplifiers and other output stages. In place of conventional output transformer and power amplifier tubes, "Moto-Mag KP10-400" utilizes a phase-sensitive vacuum tube, demodulator and magnetic amplifier output stage which obviates need for rectifiers. Each unit is built in accordance with MIL specifications. "KP10-400" operates from a minus 55 to plus 70 C. with minimum variation, and input signal of 2 volts a.c. or d.c. working into a high impedance is required for a maximum of 110 volts, 10 watts 400 cps.—*Keystone Products Co.*, 904 *23rd St., Union City, N. J.*

Mention No. 282 when filling out card.

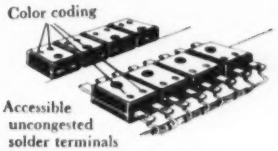
From Alden's Line of Ready-made Components for Unitized Plug-in Unit Construction:



ALDEN PATENTED

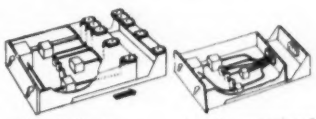
BACK CONNECTORS

Get accessible central check point for all incoming and outgoing leads



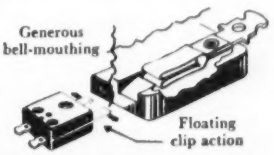
EASY SERVICING, RAPID CIRCUIT CHECKS

Solder terminals easily accessible and uncongested for multiple contact wiring. Color-coding on back connector, corresponding to lead color, identifies each lead for instantaneous check to main circuit or trunk line.



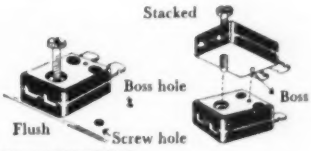
EFFICIENT CIRCUIT WIRING

Connectors can be mounted where desired—to allow for isolation of critical voltages or frequencies—to provide most direct wiring from component to connector—to eliminate rat-nest wiring of conventional methods.



EASY INSERTION AND REMOVAL

Made possible by large bell-mouth entries and ample float of rugged live-action beryllium copper contacts. Wide mating tolerances eliminate critical unit alignment problems.



EASY MOUNTING

Single screw for mounting flush or stacked. Molded locating boss positions and locks connector in place on unit when flush mounted—boss accurately lines up and positions connectors together in stack mounting.

SEND FOR FREE SAMPLES

also request free "Alden Handbook" 226 pages of techniques and components to help you design your equipment for Unitized Plug-in Unit Construction.

NA-ALD ALDEN PRODUCTS CO.

137 N. Main St., Brockton 64, Mass.

Principles and Applications of

OXYGEN RECORDERS

By O. W. RIGGS
The Hays Corporation

Oxygen recorders are finding many uses in product control, combustion control, safety monitory, and research. Important considerations are (1) techniques available for measuring combustion efficiency, (2) principles of the various commercial analyzers, and (3) sampling systems.

OXYGEN recorders are being used in four basic ways —for product control, combustion efficiency, safety monitoring, and laboratory research. In the steel industry the oxygen recorder has been used successfully on soaking pits and other heating furnaces. It has been used with some success on open-hearth furnaces, although there is work to be done on the gas-sampling problem in that particular application. In refineries the instrument has been used for analyzing the gases from the regenerators on catalytic cracking units, and for checking the flue gases on heaters and boiler furnaces. Various types of kilns also have been equipped with oxygen recorders, including lime kilns, phosphate kilns, cement kilns, and alumina kilns. Results have been satisfactory, but additional work is being done on the gas-sampling problem.

Boilers in the power field have been the most common application for the oxygen recorder. This is particularly true on large units operating with little excess air and with units burning several different types of fuel. In the gas industry oxygen recorders have been used for measuring the percentage of oxygen in natural gas and in gas mixtures. In the chemical industry it is important to measure oxygen in inert gases transporting organic dust, in gases used for purging purposes, and in inert atmospheres where explosion hazards might exist. Analysis of exhaust gases from both reciprocating and jet engines, measurement of oxygen purity, and measurement of oxygen in respiratory gases are also possible applications.

Another common industrial application is the measurement of oxygen in special furnace atmospheres for heat treating, blanketing for safety, and for purging. Safety and protection against explosive hazards is one of the most important applications. In heat-treating processes where explosive oil vapors are given off, it is necessary to blanket the material with an inert gas. In applications where highly inflammable or explosive chemicals are being mixed, it is necessary to perform the operation in an inert atmosphere. In any applications where the presence of oxygen might result in a serious explosion, gas analysis is important. In certain heat-treating and annealing operations the furnace atmosphere must be practically oxygen free and the recorder provides a continuous check on that condition.

Product control is an important application for the oxygen recorder. In the catalytic cracking unit, measurement of oxygen in the gases leaving the regenerator is important because it indicates the amount of carbon being removed from the catalyst and also safeguards against after-burning which could damage the regenerator. The gases from the regenerator contain high percentages of CO as well as some CO_2. If the oxygen content becomes too high, the CO will burn and furnace temperatures will become very high. On the other hand, if there is insufficient oxygen in the gases leaving the regenerator, the carbon will not be properly removed from the catalyst and the catalytic action will be affected, reducing the output of the cracking unit and possibly damaging the catalyst.

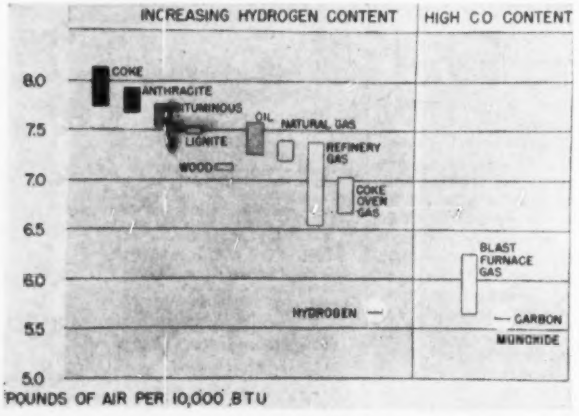


Fig. 1. Lbs. of air required for 10,000 BTU from various fuels, assuming perfect combustion.

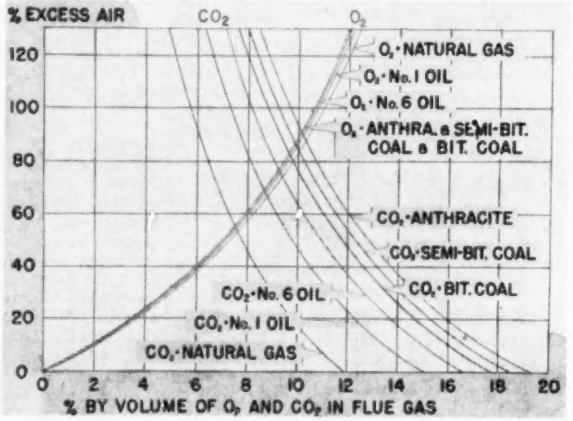


Fig. 2. Relation between excess air and oxygen and between excess air and CO_2 for various fuels.

In order to obtain maximum output from steam boilers, open-hearth furnaces, kilns, and other fuel-consuming equipments, it often is necessary to analyze the combustion gases. If, for example, the fan capacity of a boiler is a limiting factor, proper control of fuel-air ratio becomes very important. By holding the excess air to a minimum, the velocity of gases through the boiler is such that maximum heat transfer can be obtained, flue-gas temperatures are held down, and maximum steam output can be increased for a given fan capacity. The time required to run a heat in an open-hearth furnace, or the time that material must be retained in the kiln can be reduced through analysis of combustion gases.

Use of Air-flow Steam-flow Measurements as a Guide for Combustion Efficiency

Various types of combustion guides can be used for checking combustion efficiency. Under certain conditions the air-flow steam-flow meter provides a simple and practical method when there is intimate mixing of fuel and air and a satisfactory means of measuring total air flow. The fuel composition must not change greatly, and the steam pressure and temperature, feed-water temperature, feed-water flow, fuel and air temperature, and condition of the heat-absorbing surfaces must be fairly constant. The CO_2 recorder can be used to obtain a direct analysis of combustion gases independent of the variables mentioned when the ratio of hydrogen to carbon of the fuel does not change greatly.

For a number of years, steel mills and refineries have been burning a combination of fuels consisting largely of by-products of their various processes. In recent years the trend towards burning several fuels instead of a single fuel has spread to all industries. Special rates on gas at certain times, the lack of coal at other times, and the desirability of burning liquid or gaseous fuels under certain load or process conditions have influenced this trend. Because of this shift to multiple-fuel firing, the oxygen recorder is being accepted as the most practical universal guide.

Fig. 1 shows the relationship between heat release and air required for theoretically perfect combustion. The vertical axis indicates the pounds of air required to produce 10,000 BTU. The horizontal axis is not calibrated, but shows a general trend; as we move to the right the hydrogen content of the fuels increases.

If we could assume that a fixed volume of air would always release the same number of BTU, regardless of the fuel composition, we could balance air flow against heat output (assuming that we can measure the heat output). This is done successfully with the air-flow steam-flow meter on boilers where the variation in fuel composition is not too great. However, some forms of coke require over 8 lbs. of air to produce 10,000 BTU, whereas blast-furnace gas requires approximately 6 lbs. of air per 10,000 BTU.

The air requirement decreases as the hydrogen content increases. This is not a direct relationship because the BTU content of the fuel does not vary directly as the hydrogen-carbon ratio. The BTU content is dependent upon the manner in which the hydrogen and carbon are combined, particularly in coal, where many hydrogen-carbon combinations are possible. However, in general, less air is required as the amount of hydrogen in the fuel increases; pure hydrogen requires only 5.66 lbs. of air per 10,000 BTU. Wood does not follow the general trend on the graph because it contains a high percentage of oxygen and, therefore, requires less additional oxygen for its combustion.

The low air requirements of blast-furnace gas are not due to the presence of hydrogen. The amount of hydrogen present in blast furnace gas is very small, although there is some hydrogen and some methane present. However, the greatest percentage of combustible is carbon monoxide, and the air requirement for carbon monoxide is even less than that for hydrogen (Fig. 1).

The theoretical air requirement for fuels varies widely. The variation in the actual air requirement is even greater because a greater percentage of excess air is required in the burning of solid fuels to insure proper mixing of air and fuel. Because of the variation in air required for a given BTU output, any instrument comparing the quantity of heat release with the quantity of air supply must be calibrated for the fuel or combination of fuels being fired if a direct comparison is to be obtained.

Another practical consideration which makes the use of the air-flow steam-flow meter somewhat difficult on large boilers is the problem of obtaining a satisfactory measurement of total air flow. In some of the large new units there are four or more ducts carrying air through the furnace; in order to measure total air flow it is necessary to measure the flow in each duct and then totalize. Also, the problem of recirculation of gases under certain load conditions makes it difficult, if not impossible, to obtain a satisfactory measurement on the gas side of the furnace.

In a quantitative instrument such as the air-flow steam-flow meter, total steam flow and total air flow are measured.

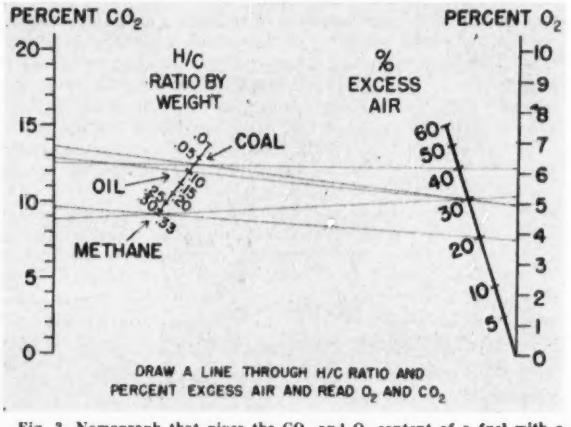


Fig. 3. Nomograph that gives the CO_2 and O_2 content of a fuel with a given H/C ratio and at a given percent excess air.

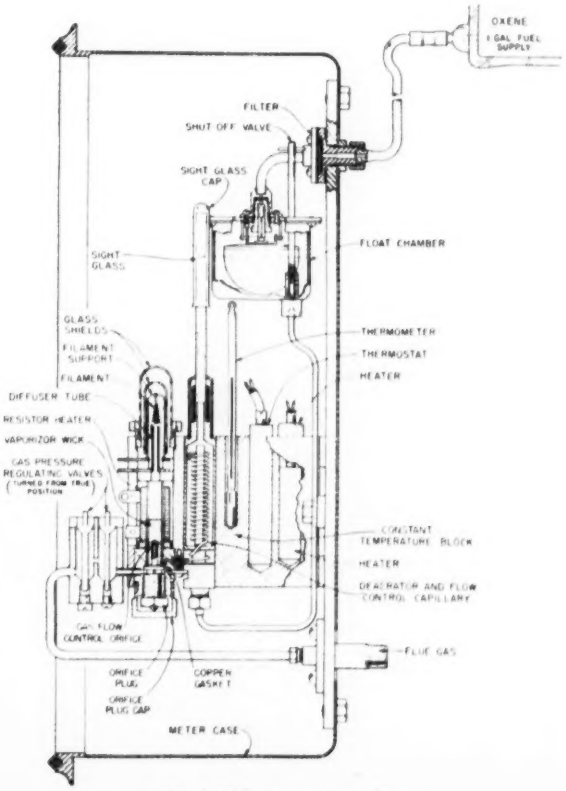


Fig. 4. Bailey oxygen recorder.

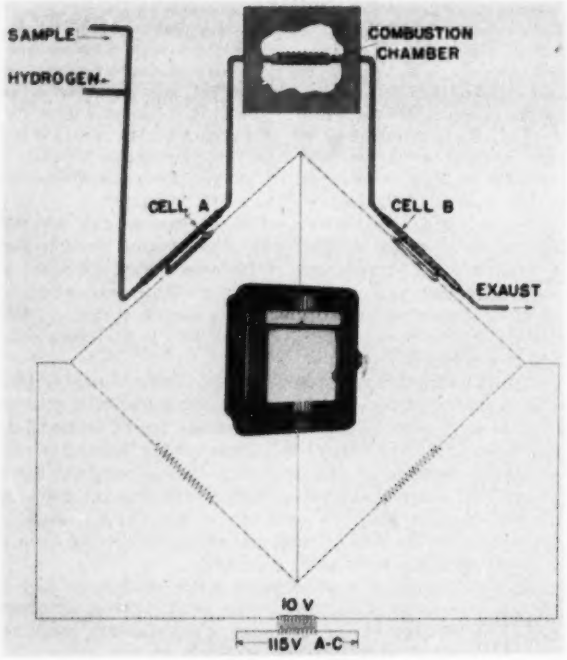


Fig. 5. L&N oxygen recorder.

This means that the excess air is only a small portion of the total pen travel on the chart. As it is the percentage of excess air that we are interested in, the movement of the pen for a given percentage of excess air is much less at light loads than it is at heavier loads. With an instrument such as an oxygen recorder, the percent oxygen representing only excess air is recorded and the index to combustion efficiency is expanded greatly.

Analysis of Combustion Gases for CO_2 and O_2

We have discussed combustion on a quantitative basis—the quantity of air required per unit of heat. Another method of checking combustion efficiency, a qualitative method, is by analysis of the combustion gases. Fig. 2 shows the relation between excess air and oxygen and between excess air and CO_2 for several common fuels. Excess air is plotted vertically and the percentage of oxygen or CO_2 in the flue gas is plotted horizontally.

For any given fuel in which the hydrogen-carbon ratio remains reasonably constant, the CO_2 recorder serves as a dependable guide because the relationship between CO_2 and excess air remains fixed. The CO_2 recorder has the advantage of actually measuring the products of combustion, and thus provides a direct check on combustion efficiency. For a boiler, CO_2 measurement does not require the assumption that a constant number of BTU is absorbed by a pound of steam, and our check on efficiency is not affected by irregularities in feed-water flow, air temperature, water temperature, fuel temperature, and other variables. However, the CO_2 varies widely as the hydrogen-carbon ratio of the fuel changes, and where several fuels are being burned CO_2 does not provide an accurate guide. Note that with zero percent excess air, the CO_2 for natural gas is approximately 12 percent. For bituminous coal it is about 18.5 percent. Blast-furnace gas is not shown, but the final CO_2 resulting from the combustion of blast-furnace gas is as high as 27 percent.

Fig. 2 shows that whereas the CO_2 content of flue gas varies for different fuels, the oxygen content of the flue gas varies only a little for the same group of fuels. For example, at 40 percent excess air the variations in oxygen content between all types of fuels shown is less than 0.2 percent. It appears, therefore, that if the percentage of oxygen in the combustion gases can be accurately measured, a true index of combustion efficiency can be obtained. This method,

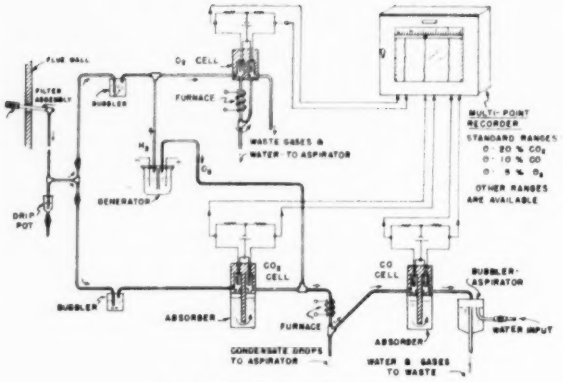


Fig. 6. Cambridge gas analyzer.

like the CO_2 method, analyzes the gases resulting from the combustion process and is not an indirect comparison.

Fig. 3 is a nomograph that gives the CO_2 and O_2 content of a fuel with a given H/C ratio and at a given percent excess air. If we know the hydrogen-carbon ratio of the fuel and the percentage of excess air that we wish to maintain, and draw a line between these two points, the line intersects the left-hand scale at the corresponding value of CO_2, and the right-hand scale at the corresponding value of oxygen. Note that the hydrogen-carbon-ratio scale runs from 0.33 (which is methane having a hydrogen weight of 4 and a carbon weight of 12) to zero (which is the hydogen-carbon ratio for pure carbon). Practically all hydro-carbon fuels fall within this span. Note also that for the same percentage of excess air, the oxygen percentage remains relatively constant for all the fuels, whereas the CO_2 varies widely with a fuel change from methane to bituminous coal.

In going from one fuel to another, it may be necessary to vary the percentage of excess air in order to insure complete mixing of fuel and oxygen. That means that the oxygen percentage must change slightly. However, it does not mean a recalibration of the instrument because we obtain a direct reading with the oxygen recorder and do not rely upon a comparison of two records. Therefore, if we go from methane at 20 percent excess air to bituminous coal at 40 percent excess air, our oxygen reading would change from about 3.7 to 6.1 percent. However, as we know the percentage of excess air to be maintained, the proper oxygen reading can be determined readily. It appears, therefore, that where the composition of the fuel varies widely, the measurement of the oxygen in the combustion gases provides the most direct check on efficiency of combustion.

Bailey Oxygen Recorder

The Bailey oxygen analyzer (Fig. 4) operates on the catalytic-combustion principle, utilizing a noble-metal catalyst-filament. The gas to be analyzed is passed through the gas-pressure regulating valves immediately ahead of the gas flow control orifice. This measured gas sample mixes with a measured quantity of vaporized, standardized liquid fuel. The flow of fuel is regulated by a float-operated valve and a flow control capillary from which the fuel flows to a vaporizer wick. The gas sample and vaporized fuel are passed over the catalyst filament, where combustion of the fuel takes place. The heat liberated by combustion maintains the filament at a temperature proportional to the oxygen content of the sample.

The filament forms one leg of an a-c. measuring bridge. Unbalance in the bridge circuit produces a signal for an electronic amplifier which controls a motor-driven slidewire to maintain a continuous balance in the measuring circuit. The recording pen is mechanically connected to the motor and may be calibrated in terms of percent oxygen, percent excess air, or fuel-air ratio.

Leeds & Northrup Oxygen Recorder

The L & N oxygen recorder uses the hydrogen-difference method of oxygen determination (Fig. 5). A sample of the gas to be analyzed flows into the sampling line and is mixed

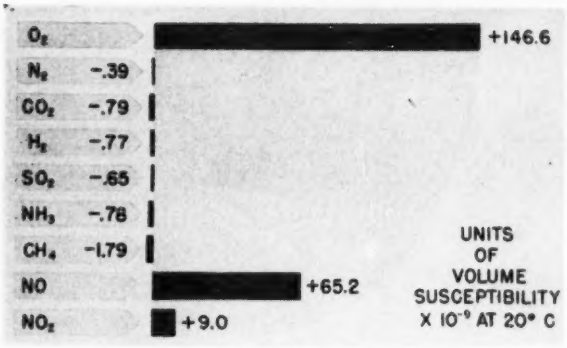


Fig. 7. Magnetic susceptibility of several gases.

with hydrogen. The mixture is then passed through cell A. The gas then enters the combustion chamber where the hydrogen and oxygen combine, removing from the sample all of the oxygen and equivalent hydrogen. The balance of the sample then passes to cell B. Because the hydrogen content has been lowered, the *thermal conductivity* of the gas in cell B is lower than that of the gas in cell A. The difference in thermal conductivity causes a difference in the electrical resistance of the two cells, which are in a bridge circuit. The resistance difference produced by the change in hydrogen content is calibrated in equivalent oxygen units. Hydrogen is used because the thermal conductivity of hydrogen is high compared to other gases. Thus a small change in the hydrogen content (caused by a small change in oxygen content of the sample) produces a substantial unbalance in the bridge circuit and yields high sensitivity.

The gas sample is drawn through a primary filter and sampling line into the cell cabinet by means of an aspirator or pump. Hydrogen is supplied from a cylinder. The percent of oxygen is continuously indicated and recorded on a remotely mounted electrical recording instrument, which measures the electrical resistance changes in the bridge circuit.

Cambridge Gas Analyzer

The Cambridge gas analyzer (Fig. 6) for CO_2, CO, and O_2 also uses the hydrogen-difference method of measuring oxygen. The sample of gas is drawn into the analyzer through the primary filtering element by a water aspirator. One of the principal differences between this instrument and the L & N analyzer is that the Cambridge analyzer has a generator for producing the hydrogen which is mixed with the gas sample before entering the oxygen-determination cell. The mixture passes through the left-hand chamber (reference chamber) in the O_2 cell and then through the electric furnace, where the oxygen is reduced to water vapor by combining with the hydrogen. The sample is then passed through the active side (right-hand chamber) of the oxygen cell. The loss in hydrogen produces a difference in thermal conductivity and hence in electrical resistance, which is measured and recorded in units of oxygen. Note that a thermal-conductivity cell has two cells—a reference cell and an active cell.

Thermal-conductivity measurement of CO_2 is obtained by passing the sample into a reference cell (in the CO_2 cell), then through an absorber which chemically absorbs the CO_2, and then to the active chamber in the CO_2 cell, where the change in thermal conductivity of the gas is measured. The remaining portion of the gas sample is mixed with oxygen from the electrolytic generator, passed through a furnace where any CO in the sample combines with the oxygen, forming CO_2. The sample then enters the reference CO cell then through an absorber where the CO_2 is absorbed, and then into the active chamber of the CO cell. The difference between the thermal conductivity of the gas before and after absorption of CO_2 is a measure of CO.

Magnetic Susceptibility of Oxygen

At present there are at least two oxygen recorders on the market employing the magnetic susceptibility of oxygen as a basis for oxygen measurement. Normally we do not think of gases as being magnetic or non-magnetic. However, there are a few gases which possess definite magnetic qualities. Oxygen is one of these gases; a stream of oxygen or gas containing oxygen can be attracted by a magnetic field. Fig. 7 shows the magnetic susceptibility of oxygen and other gases. Oxygen is paramagnetic (attracted into a magnetic field) and has a positive index of 146.6. Most other common gases are diamagnetic (repelled out of a magnetic field) and have negative indices. However, their effects are small and the presence of these gases in rather large quantities does not introduce any serious magnetic problem. NO and NO_2 are paramagnetic also. However, they are not normally encountered in combustion work and other common applications. Therefore, a measurement of the magnetic properties of a gas can be interpreted in terms of its oxygen content.

Beckman Oxygen Analyzer

The Beckman oxygen analyzer (Fig. 8) depends for its operation on the fact that oxygen is strongly paramagnetic. Magnetic susceptibility is measured by suspending a dumbbell-shaped test body in a non-uniform magnetic field. The test body is surrounded by the sample gas. If the sample gas surrounding the test body is more paramagnetic than the test body, the gas forces the test body away from the region of maximum flux densities. Conversely, if the sample gas is less paramagnetic than the test body, the test body is drawn toward the region of maximum flux densities.

The test body is a light dumbbell-shaped element made of two small hollow glass spheres supported on a quartz fiber, together with a small mirror which indicates the angular position of the assembly. The test body is free to rotate in the non-uniform permanent-magnet field, and is subject to a magnetic force proportional to the differences between the volume magnetic susceptibilities of the test body and the gas which the test body displaces.

In the Beckman deflection-type analyzer, the test body rotates to an equilibrium position at which the magnetic rotational force is balanced by the torsional restoring force

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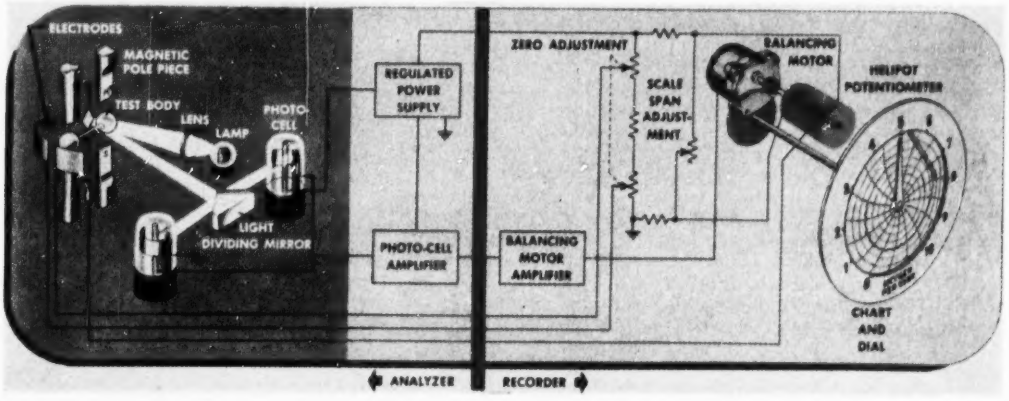

Fig. 8. Beckman null-type oxygen analyzer.

TRANSISTORS

Transistors are making possible the miniaturization of electronic circuits by an order of magnitude. This addition to Chapter 9 of "Instrument Electronics" presents the principles and operation of transistors. The entire series will be available in book form within 60 days.

By MILTON H. ARONSON
Technical Editor, *Instruments*

TRANSISTORS

A transistor is a solid piece of semiconductor whose resistance is controllable. The semiconductor material (usually germanium or silicon) is a crystalline substance with a small amount of chemical impurity. The impurity is necessary so that the atomic crystalline structure is imperfect—that is, contains either too few or too many electrons. These "free" electrons can be controlled so that the crystal has controllable resistance, just as the plate current of an electron tube is controlled by the plate resistance of the tube.

Note that the dielectric or magnetic amplifier is a controllable reactance, the electron tube is a controllable resistance, and the transistor is a controllable resistance also. Thus the transistor is the most like the electron tube. Whereas the vacuum tube operates by controlling the flow of electrons emitted by a cathode, the transistor operates by controlling the resistance of a solid piece of semiconducting crystal.

n-type and p-type Materials

In order to have controllable resistance, the semiconductor must contain a small amount of chemical impurity. A small amount of arsenic or antimony causes the germanium crystals to have *excess electrons* in the atomic structure. Thus arsenic or antimony is called *donor* substance, and the germanium-arsenic crystalline matter is called *n-type* (negative-type) germanium because it has excess electrons. The excess electrons can move through the *n*-type germanium when voltages are applied across the crystal.

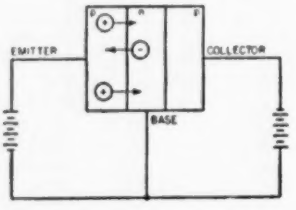

Fig. 9-9. A p-n-p junction transistor, showing motion of electrons and "holes."

A small amount of aluminum or gallium (called *acceptor* material) causes the semiconductor crystalline structure to have a deficiency of electrons, leaving *holes* (places where electrons would normally be) in the atomic structure. This type of germanium is called *p-type* (positive germanium) because it is deficient in electrons. When an electron from a neighboring crystal moves into the hole in the structure of a crystal, a hole is left in the atomic structure of the neighboring atom. Hence the hole can be said to move through the substance. A movement of such holes is a flow of current with reversed polarity. Note that the six new terms of transistor electronics—hole, excess electron, donor, acceptor, *n*-type germanium, and *p*-type germanium—all refer to imperfections in the otherwise perfect crystalline structure of semiconductors. The current flow through the semiconductor is said to be a diffusion of electrons (or holes) through the crystalline atomic structure.

There are two types of transistors—point contact and junction. Both operate by controlling the flow of current through the interface, or junction, between *n*-type and *p*-type material.

Interface Effect

Fig. 9-9 shows a *p-n-p* junction transistor, made of a solid piece of germanium with impurities added so that the ends are *p*-type whereas the middle portion is *n*-type. Consider what occurs across one interface when no voltages are applied to any of the electrodes attached to the germanium.

As the *n*-region has excess electrons, and as the *p*-region has too few electrons (holes in the atomic structure), electrons flow to the *p*-region and holes flow to the *n* region. This soon causes an electric field to build up across the interface so that further current flow is impossible. Thus a *potential barrier* is developed at each interface layer, even though no external voltages are applied. This barrier is called a *dipole layer*. It is similar to the potential generated across the interface of a thermocouple junction.

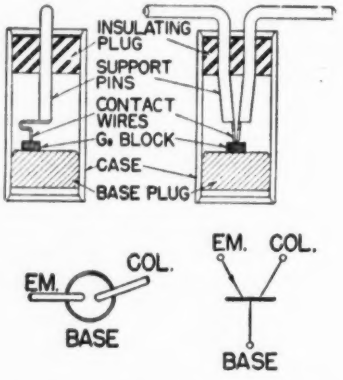

Fig. 9-10. A point-contact transistor, showing construction, top view, and symbol. (The symbol is the same for junction types.)

In the point-contact transistor (Fig. 9-10), two "cat-whisker" contacts are made to a piece of *n*-type germanium. A small area under each contact is made into *p*-type material by passing large currents through the electrodes. This "forming" process causes *p-n* junctions to be produced, as shown in Fig. 9-11.

The interfaces between the *n*-type and *p*-type materials is shown by the dotted lines. Note the essential similarity between the point contact and junction transistor. Both have two *n-p* layers. The point-contact transistor can be thought of as a *p-n-p* transistor.

Current Flow

The three electrodes are the *base*, the *emitter*, and the *collector*. The symbol for transistors (Fig. 9-10) is the same for both junction and point-contact types.

The controlled current (I_2 in Fig. 9-12) is the flow of electrons from collector to base. Thus the collector-to-base path of the transistor is analogous to the cathode-to-plate

path of the vacuum tube. However, the collector is biased negative with respect to the base, which is the opposite of the situation in electron tubes. The load is put in the collector circuit; R_2 is the load in Fig. 9-12.

Amplification Principle

The emitter controls the main collector-to-base current; hence the emitter corresponds to the grid of the electron tube. The emitter is biased slightly *positive* with respect to the base. This positive charge causes the electrons near the emitter to be attracted to the emitter, leaving *holes* in the atomic structure near the contact. Thus the emitter is said to emit holes (hence its name). The holes (of positive charge) diffuse toward the negative collector.

On reaching the dipole barrier around the collector (Fig. 9-11) the holes change the potential barrier so that *more* than one electron can cross the barrier for each hole that reaches the barrier. Thus a small current in the emitter can control a larger current in the collector; and the device is an amplifier. The collector obtains its name from the fact that it withdraws the holes emitted by the emitter. The current gain, or *alpha*, of a transistor is the ratio of collector-current change to emitter-current change. In effect, the emitter controls the effectiveness of the interface barrier.

Note that hole current is actually electron current of reverse sign. It is descriptive, however, because the electron

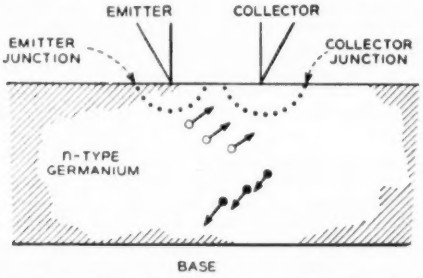

Fig. 9-11. Point-contact transistor after forming, showing interface junctions between n-type germanium and p-type regions made by the forming process. The positive holes from the emitter region control the electron flow to the base.

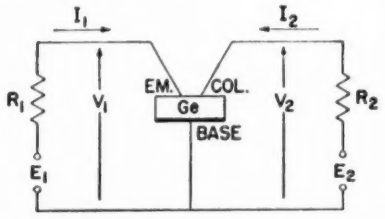

Fig. 9-12. Basic transistor circuit. I_1 is the controlling current; I_2 is the controlled current; R_2 is the load; V_1 is 0-10 volts; V_2 is 1-100 volts.

motion causes a movement of holes through the crystalline matter.

There is simultaneous flow of electron current and hole current in regions of the transistor. The larger often is called the *majority carrier;* the smaller the *minority carrier.*

Operation

The junction transistor is characterized by high current gain, high transconductance, and high collector impedance (megohms). Gains of 50 db per stage are possible. As the collector current is controlled by emitter *current* and is relatively insensitive to emitter and collector voltage, the transistor characteristic is more like that of a high-gain pentode than of a triode—that is, the output has high impedance, and the stage has high gain. As the collector current can be made to saturate at a low voltage (and at a low current of a few microamperes), amplifiers and oscillators can be made with power supplies furnishing microwatts of power. Herein is the main promise of the transistor—amplifiers and oscillators are possible with low-voltage supplies furnishing only microwatts of power. Much work is being done in reducing the size of resistors, capacitors, and batteries, because the size of components depends on the power they must handle.

The capacitance of the junction transistor is higher than that of the point contact, limiting the upper frequency of operation. The point-contact transistor also can be made to more precise tolerances than the junction. However, the latter has a better noise figure, higher collector impedance and, hence, higher voltage gain. As the junction transistor has no "catwhiskers" it is more rugged.

An important feature of transistors is that the emitter must produce current. Hence the emitter resistance is much lower (several hundred ohms) than the input grid resistance of an electron tube, which is several hundred megohms. The output resistance of the transistor (about 20,000 ohm) also is lower than that of a pentode (about 500,000 ohms).

Fig. 9-13 shows a typical transistor push-pull class-B amplifier for speech use, which can produce about ½ watt of audio power. At low levels the supply drain is only 0.1 watt, half of which is for the microphone. One hearing-aid-type battery can supply this low power. Fig. 9-13 also shows a typical oscillator. The tetrode shown has an electrode attached to the center portion of a junction transistor. This reduces the base resistance and increases the frequency of operation.

The *disadvantages* of transistors include low power-capacity, high noise-level, and frequency-response limitations. The power-handling capacity of transistors is much less than that of either electron tubes or magnetic amplifiers; they can be used in applications involving less than a few watts of output power.

Transistors are useful as amplifiers or oscillators up to frequencies of about 50 Mc. However, they are smaller and lighter than vacuum tubes and, as they have no filament, they require no warm-up time. Unlike magnetic and dielec-

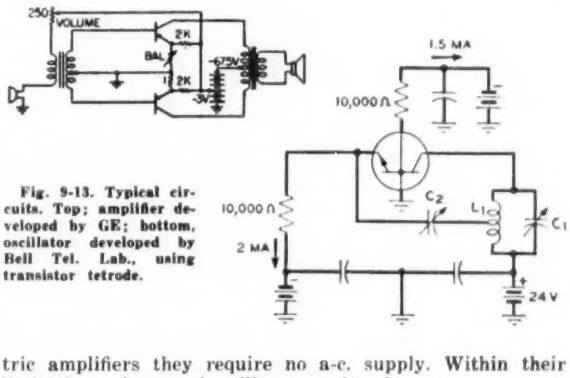

Fig. 9-13. Typical circuits. Top; amplifier developed by GE; bottom, oscillator developed by Bell Tel. Lab., using transistor tetrode.

tric amplifiers they require no a-c. supply. Within their limitations of power-handling capacity, frequency response, and inherent noise level, they can perform many tasks now assigned to electron tubes. They have been used in amplifiers, oscillators, and pulse generators at radio, intermediate, and audio frequencies. Lifetimes in excess of 70,000 hours, and shock resistance better than 20,000 times the force of gravity are claimed. Developmental transistors are said to operate at 225 Mc.

Questions to be added at end of Chapter 9:

9-21. The load in a transistor amplifier is placed in the
(a) emitter circuit
(b) collector circuit
(c) junction circuit
(d) hole circuit

9-22. The emitter controls the current through the load by
(a) changing n-type germanium to p-type
(b) emitting fewer electrons
(c) controlling collector-to-base resistance
(d) causing the germanium to emit electrons

9-23. An advantage of junction transistors over point-contact transistors is
(a) less noise
(b) lower collector impedance
(c) no n-type germanium
(d) no p-type germanium

9-24. An advantage of point-contact transistors over junction transistors is
(a) higher collector impedance
(b) higher operating frequency
(c) more ruggedness
(d) simpler circuitry

The series "Instrument Electronics" is now on the press and will be available within 60 days as a text, including over 450 home-study multiple-choice test items.

Control of Chemical Processes

Part II of this series covers the vital first consideration in any measurement and control application—detecting-element response, including methods of analysis.

By
A. J. YOUNG
Chief of Instrumentation, Imperial Chemical Industries, Ltd.

Time lag occurs between a change in plant conditions and the receipt of a warning of this change by the operator or by the controlling unit. This time lag is due to the finite time required for the following actions to take place: (i) The detecting element to come to equilibrium with the new value of the measured condition; (ii) transmission of the signal from the detecting element to the measuring element; and (iii) the measuring element itself to measure the signal and either to indicate its value to the operator or to pass it on to the controlling unit.

Almost always, in any measuring system, one of the three sources of lag is much more important than the other two. In attempting to minimize lag, this source should be considered first and all possible steps taken to reduce its effect. For example, in temperature measurement, lag (i) is usually the greatest. In pneumatic transmission, lag (ii) can be greatest. In flow measurement with an orifice and manometer, lag (iii) can be greatest.

In this article we shall be concerned solely with (i), the time lag of the detecting element.

Any time lag in measurement implies a measuring *error* whenever the measured condition is changing. The detecting element supplies the measurement not only late but also inaccurately, except in steady conditions. The "slower" a detecting element is, the less chance it has of attaining equilibrium with a continuously changing measured condition. A large disturbance may not be shown up at all if it is of sufficiently short duration compared to the measuring lag. This explains many a steady record which has been produced as evidence of steady control, when, in fact, the plant has been suffering consistently from short-period disturbances.

Of the most common measurements in the plant, namely temperature, pressure, flow and level, temperature measurement suffers most from time lag and presents the most difficult problems in eliminating it. The following discussion is therefore mainly concerned with the lag in temperature detecting elements. Some general remarks of practical interest on lag in other detecting elements will be made in a later article. The same general theory, however, applies to them all.

Apart from the three sources of lag in the measuring unit, which were given at the beginning of this section, there are three more sources in the complete control loop, namely: (1) Lag in the controlling unit; (2) lag in transmission of the controlling unit signal to the regulating unit and in the response of the latter; and (3) lags in the plant between corrective action at the regulating unit and response at the detecting element. ("Distance-velocity" and "transfer" lags).

Definition of "Measuring Lag" for a Detecting Element

The rate at which a bare temperature-detecting element changes temperature in response to a change in the temperature of its surroundings depends on: (1) The thermal capacity (C) of the element and (2) the rate at which heat is exchanged between the element and its surroundings. This rate depends on (a) the resistance to the flow of heat (R) across the boundary between the element and the fluid surrounding it, and (b) the difference in temperature between the element and the fluid.

Note that the thermal capacity of the element is a property of the element itself. The resistance to heat flow, however, depends on the nature of the fluid and the speed at which it flows over the element. The resistance of the boundary layer increases as the thermal conductivity, specific heat, and density of the fluid increases, and decreases as its viscosity increases. As the resistance for a gas is 50 or 100 times higher than for a liquid with the same speed past the element, it is more difficult to obtain rapid response in measuring the temperature of a gas.

We can define the measuring lag in terms of C and R, as defined above.

Case 1. *Temperature-detecting elements subjected to sudden change in temperature of surrounding fluid.*

If a temperature-detecting element is suddenly plunged into a fluid at a higher temperature, the *rate* at which it commences to rise to the new temperature will be proportional to the initial temperature difference and to $1/CR$. We can therefore regard CR as a constant. As the temperature difference decreases, the rate of rise of temperature of the element decreases proportionately until it finally becomes infinitely small. The response curve therefore will be of the shape shown in Fig. 2-1 for a bare thermocouple, which is an exponential curve.*

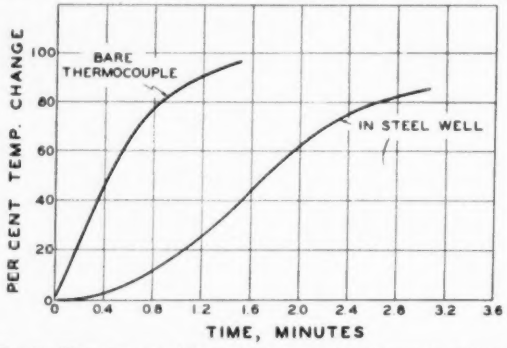

Fig. 2-1. Response of (a) bare element and (b) element in well to sudden, sustained change in ambient temperature. Note delayed start of curve at right.

Measuring lag often is defined and experimentally determined as the time which elapses before the initial temperature difference between the element and the measured condition is reduced by a fixed percentage. Any arbitrary percentage could be used, but it is usual to take (in round figures) 63 per cent. This percentage is taken because in a time interval (T) of RC seconds, the exponential passes through 1-1/e, or 63.2 percent, of its final amplitude change.

This "step change" approach is not discussed further because sudden changes in conditions are in general neither

*Since all detecting elements have both distributed resistance and capacity, they do not follow the exponential law exactly—but the error involved is not appreciable for our present purpose. For a detailed discussion of this point see M. F. Behar, *Instruments*, Aug. 1948, pages 691-698.

desirable nor easy to produce in a plant. Therefore lag will now be discussed and defined in terms of a continuously changing measured condition.

Case 2. Temperature-detecting elements subject to constant rate of change in temperature of surroundings.

If the plant fluid temperature is increased at a constant rate, the response of the temperature-detecting element will be as shown in Fig. 2-2. After sufficient time has elapsed, the indicated temperature will lag behind the actual temperature of the fluid by a constant amount. The distance between the two parallel lines on the time axis in Fig. 2-2 is the measuring lag (T), and $T = CR$. (See appendix). If the indicated temperature lags behind the actual temperature by θ degrees, the heat absorbed by the element must be $\theta \times C$. But the temperature difference is constant at θ, and rate of heat flow to element is therefore θ/R. Hence

$$(\theta/R)\ T = \theta C$$
$$T = RC.$$

This method of determining T is flexible for both laboratory and plant use. It has the advantage that measurements are taken over a period so that erratic disturbances can be averaged out by drawing the parallel straight lines through the points determined experimentally.

Case 3. Temperature-detecting element subject to a disturbance varying continuously in sine wave form.

The output of the element is measured and is also of sine wave form (Fig 2-3). However, (a) the detecting element never reaches the maximum or minimum temperatures

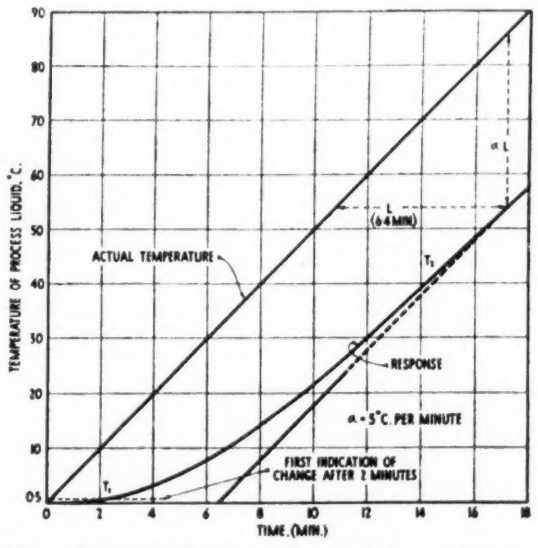

Fig. 2-2. Response of element in well to constant rate of change of process temperature. (Element used is shown in Fig. 4.)

to which it is exposed, (b) the maximum and minimum points on its own response curve lag behind those of the impressed disturbance, (c) as the measuring lag T becomes larger, the response has smaller amplitude and the lag of response increases, and (d) as the frequency (n) of the impressed disturbance is increased, the attenuation and lag of response signal become greater. The formulae for element lag (L) in terms of signal attenuation and phase lag are given in the appendix.

Plant engineers will appreciate that the lag measurement can easily be made in this way on the plant itself, by setting the controller to produce steady "hunting". By recording the temperature as measured by the element under investigation and also by a special element with negligible lag, the curves of Fig. 2-3 can be produced and compared.

It is suggested that the most reliable way of finding L for an actual plant installation is this method. If not practical, the "continuous rate of temperature increase" (Case 2) should be used.

Detecting Element in Protective Well

When the element is housed in a protective well, the rate of transfer of heat to the element from the plant fluid is decreased because of (i) well wall resistance; (ii) resistance of air or filling medium between element and pocket; and (iii) resistance of any dirt layer which generally collects on the well in plant conditions.

In addition, the well introduces more material to be heated to the final temperature. This additional thermal capacity increases the measuring lag further.

Finally, additional heat will be lost by conduction along the well wall to the pipe wall and atmosphere. This heat loss has the same effect as an increase in thermal resistance because it effectively decreases the rate of heat flow to the element.

Thus the well is responsible for the major part of the measuring lag in most temperature installations. It is worth while to consider the relative orders of magnitude of the contribution of each component of the installation to the total measuring lag by taking a specific example.

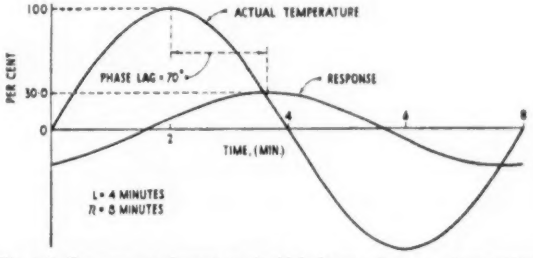

Fig. 2-3. Response of element to sinoidal change of process temperature, showing attenuation and phase lag.

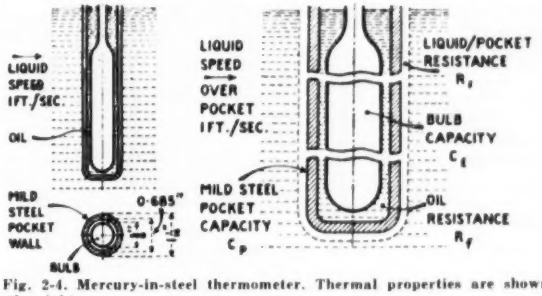

Fig. 2-4. Mercury-in-steel thermometer. Thermal properties are shown at the right.

Example of Element-in-well Response

The following example refers to an existing installation in a chemical plant. The well (Fig. 2-4) is about 10-ft. long (in a vat used for a batch process); therefore losses by conduction along the well to the external atmosphere need not be considered in this instance.

As shown in Fig. 2-4 the heat transfer takes place through the resistances R_F, R_p *and* R_f (fluid film, well wall and filling liquid respectively) before it reaches the element. The thermal capacities which account for delays are (C_p) well wall capacity, (C_f) filling liquid capacity, and (C_E) element capacity.

An approximate expression for the time lag L is:

$$L = C_E R_f + (C_E + C_p)(R_F)$$

and the response curve is shown in Fig. 2 for a steady rise in process material temperature.

In this equation, note that there are two ($C \times R$) terms or time constants. These make the element slow at the beginning of any change.

It is important to note how this shape affects control: (1) The controlling unit will first know corrective action is necessary, and in which direction, at time T_1 *after* the change has commenced, where T_1 is the time at which the measuring unit is just able to detect the signal from the

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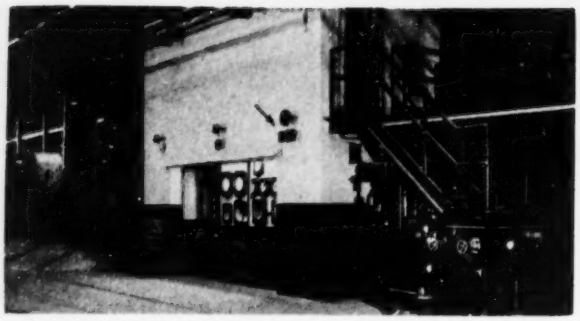


Fig. 1. Equipment on the new No. 4 Open Hearth Shop of Pittsburgh Works, Jones & Laughlin.

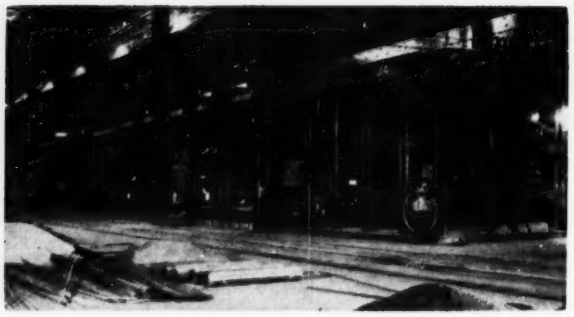


Fig. 2. Furnace front, showing extension lead-wire box to the right of the last door.

Open-hearth Bath Temperature Measurement

The development of a light, easily assembled thermocouple for open-hearth use is traced through its stages. Operational results are given.

By F. S. SWANEY

Jones & Laughlin Steel Corp.

IN FEBRUARY, 1951, the Steam Efficiency and Combustion Department of the Pittsburgh Works of Jones and Laughlin was assigned the responsibility of maintenance of all metallurgical instrumentation. Although this new work entailed installation and service work on all types of temperature-measuring equipment used throughout the plant for metallurgical control, the greatest problems were encountered with open-hearth bath-temperature measurement. Our facilities at that time consisted of four 225-ton tilting furnaces equipped for radiation-type measurements, and two 175-ton tilting furnaces equipped for thermocouple-type measurements. Three other 175-ton furnaces were not equipped for bath-temperature measurements.

Although the radiation-type equipment had been in service longer than the thermocouple type, operating experience on both types had been such that opinions had jelled in favor of the thermocouple type. It is believed that either of these types may be made to work equally well if properly engineered, installed, and maintained. For example, our sister plant at Aliquippa has had remarkable success with the radiation type and all their open-hearth furnaces are so equipped. However, shortly after we entered the bath-pyrometer field we converted four radiation-type-equipped furnaces to thermocouple type; in addition, we extended the thermocouple system to the remaining three furnaces not so equipped. As the use of thermocouples was extended from two furnaces to nine furnaces in a short time, we found thermocouple design to be a major problem.

Original Thermocouple Design

The thermocouple in use at the time we inherited this equipment is shown in Fig. 5. It consisted of ½-inch extra-heavy pipe inserted in a length of 2½-inch-O. D. thin-wall tubing. the annular opening between the two being filled with "Sil-o-Cel" insulation. The thermocouple and leadwire was in the ½-inch pipe. A graphite head was press-fitted over the end of the ½-inch pipe, and accommodated a tapered graphite plug. This plug was drilled to receive the quartz silica sheath, which protected the thermocouple tip. The end of the unit was built up with silica clay. About half the length of the unit was wrapped on the outside with asbestos wicking, after which successive coats of "Ferro Bond" cement were applied in order to protect the outer surface during immersion.

Although this unit gave satisfactory results, it was considered impractical to extend its use for the following reasons: (1) Although the unit weighed 50 lbs. when new, slag build-up and repeated patching of the refractory coating caused the unit to weigh up to 90 lbs. (2) Each reading taken necessitated patching of the refractory coating on the outside of the tube. This in turn required drying time to prevent a boil on the thermocouple. Drying time meant thermocouple outage and necessitated a stock of thermocouples. (3) Drying also entailed drying space and drying facilities. (4) The unit could not be disassembled readily; irreparable damage to any part of the unit necessitated scrapping of the whole unit except the thermocouple wire.

Improved Thermocouple Design

In the course of a design which would remove the limitations, we were fortunate enough to pay a visit to the Pittsburgh plant of the Heppenstall Co. where Mr. Lester Veiock demonstrated how easy it is to measure bath temperature. Therefore, based partly on his ideas and partly on our ideas, we designed the unit shown in Fig. 6.

The working, or hot end, of this couple consists of 2.5-inch carbon sleeves slid over a 1-inch standard pipe. The end carbon block is drilled to receive a tapered plug. This plug holds the quartz sheath for the thermocouple tip. The quarts tip is centered in the carbon plug, and the plug and quartz tipped units are made up ahead of time in quantity. The thermocouple assembly is carried in a ⅜-inch standard pipe which runs down the center of the 1-inch standard pipe. The back four foot of the unit handled by the operator consists of 2½-inch-O.D. tubing. The carbon train is kept from falling off the pipe by means of the threaded pipe coupling at the end of the ⅜-inch pipe. Note the overlapping joints on all the carbon blocks. These are kept under tension at all times by a spring at the cold end of the thermocouple. The unit is a little over ten feet in length and weighs approximately 45 lbs.

Maintenance on the unit shown in Fig. 6 is simple compared to the one shown on Fig. 5. During a normal reading and with any depth of slag blanket, the carbon train receives a nice coating of slag before it hits the steel. Thus maintenance between readings consists merely of knocking off the slag coating (which comes off easily), and removing and replacing the plug and silica sheath at the end of the

Presented at the Conference "Instrumentation for the Iron & Steel Industry," April, 1952, Pittsburgh, Pa.

Fig. 3. Operator inserting thermocouple.

Fig. 4. Instrument man removing plug from thermocouple after use.

couple. Other than on the plug and tip assembly, no refractory cement is used; therefore no drying time is required. The couple can be disassembled easily by backing off on the steel nut to the left of the spring, slacking off on the tension of the assembly, and then taking out the carbon plug and backing off the carbon blocks far enough to remove the threaded coupling from the end of the ⅜-inch pipe. All of the carbon sleeves can be removed.

As with any piece of equipment, we found some "bugs." The No.-12-gauge wire used throughout the 2.5-inch-O. D. tubing protected the tubing from flame, erosion, and scaling; but it had its drawbacks. Installation of this wire entailed spot welding the wire at different points along the tubing. Some trouble was encountered with the welding operation because the heat burned through the wire itself. Thus fabrication time was too long. Also, owing to the repeated heating and cooling of this wire, it stretched and loosened considerably during service. This resulted in an unsightly rough surface. Another item we wanted to change was the pipe insulation between the 2.5-inch tubing and the 1-inch pipe; filling and tamping the insulation into the annular opening between these tubes is a tedious job. Another problem which arose was that on some immersions the unit came out of the bath without the carbon plug in the end of the couple. We tracked that down to the fact that when the first helper inserted the couple in the wicket hole he pushed forward. Sometimes he pushed on the spring and if any rough surfaces on the outside of the tubing caught on the wicket hole the ⅜-inch pipe was forced down through the center of the thermocouple and pushed the plug out. Thus we wanted to prevent the operators from doing this.

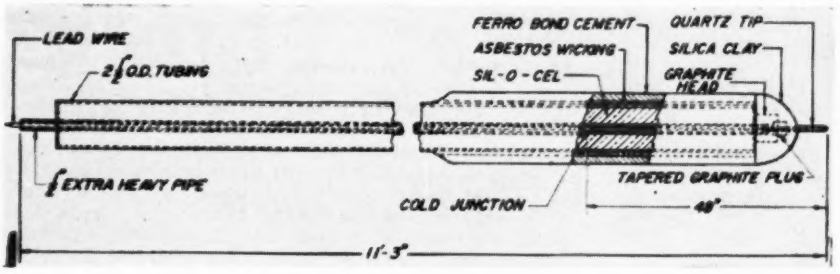


Fig. 5. Original thermocouple design.

Fig. 6. Improved thermocouple design.

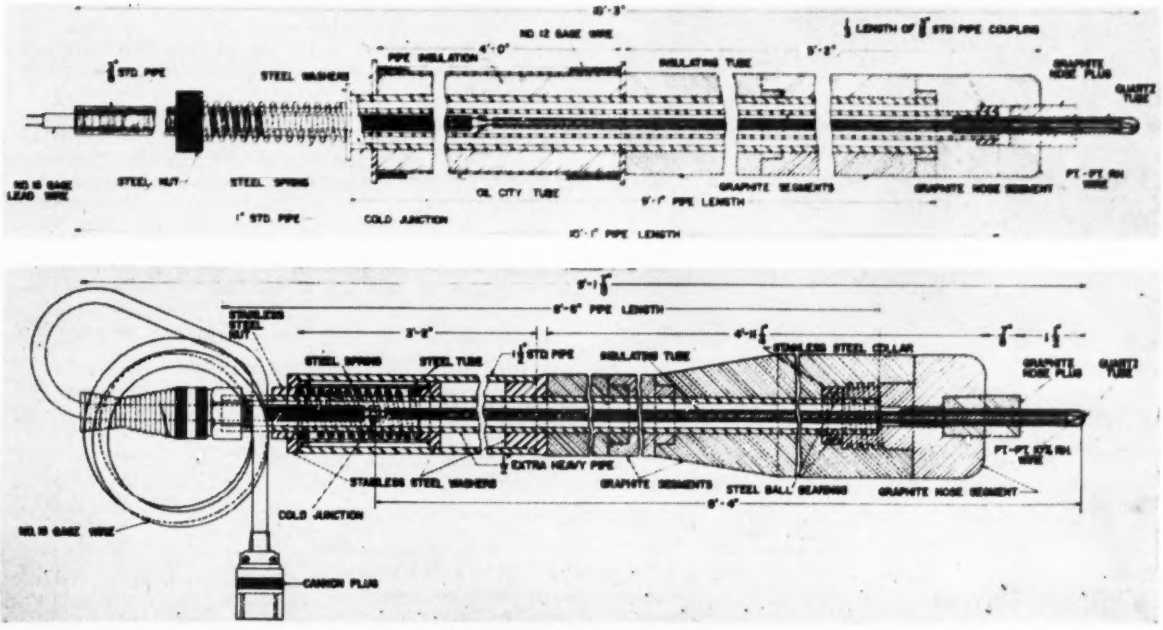


Fig. 7. Latest thermocouple design.

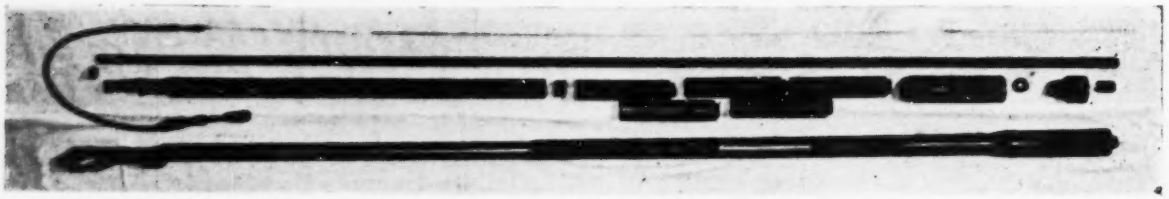


Fig. 8. Thermocouple, disassembled and assembled.

Final Thermocouple Design

Based on experience, we finally came up with the couple shown in Fig. 7 which, except for minor changes, we are now using. The number of pipes has been reduced from two to one—one length of ½-inch extra-heavy pipe running down the center of the thermocouple. This pipe houses the thermocouple assembly and serves as a base over which the carbon sleeves are slid. The diameter of the whole couple, with the exception of the last two pieces of carbon on the hot end, has been reduced from 2½ to 2 inches. The spring at the cold end of the thermocouple has been concealed within a spring-retainer assembly, which is the only welded part of the thermocouple. Once fabricated, it forms an integral part of the assembly. Note that we still have the overlapping joint between the adjacent pieces of carbon. To eliminate the machining necessary for this joint, we recently have tried a couple with butted joints between carbon sleeves. This has worked out well and, if this success continues, we will swing over to this cheaper construction. The last foot or so of carbon at the hot end is 2.5-inch diameter, swedged down to 2-inch carbon sleeves. The nose is held into the adjacent 2.5-inch carbon sleeve by a threaded joint.

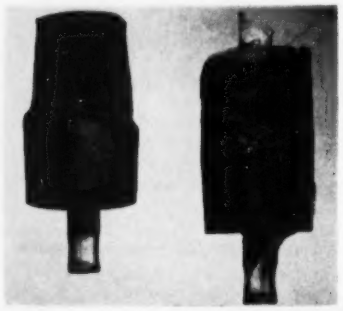
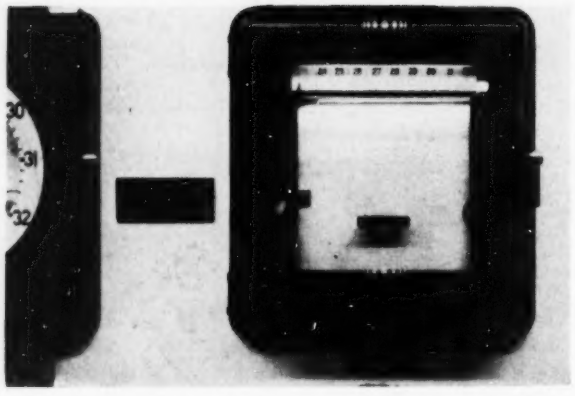


Fig. 9. Plugs after one use.



Note the locking device employed at the hot end of the couple to lock the ⅜-inch pipe to the carbon train. This ingenious detail was suggested by the machinist who did the machine work. The end of the ⅜-inch pipe is unthreaded and a ¼-inch drill is used to countersink three holes around the outside diameter of the pipe. The couple is then assembled and the carbon train and tubing assembly is slid to the left, exposing the three holes. The stainless-steel retaining collar then is slipped over the pipe and into the recess in the carbon piece. Three ¼-inch-diameter ball bearings then are dropped into the countersunk holes. The whole assembly of carbon train, tubing, and collar is pushed to the right until the collar bears down firmly on the ball bearings. This arrangement permits ready disassembling and reassembling of the thermocouple.

We have had some trouble with the 2-inch thin-wall tubing in the handle bending and crimping, particularly at the point where the wicket hole intersects the thermocouple during a normal reading. We have tried substituting 1.5-inch standard pipe for this thin-wall tubing and have had excellent results.

The thermocouple assembly, when new, is 100 inches long. The soldered joint between the platinum—platinum-rhodium thermocouple and the compensating rubber-covered lead-wire is approximately in the middle of the spring-retainer assembly. The cold junction can be as much as 4 feet in the unit before we run into measurable cold-junction errors. On a new unit, therefore, the length of rubber-covered extension lead-wire extending beyond the spring cord protector is four feet and, as usage demands, the lead wire is fed down through the center of the tube. As this limitation on cold-junction compensation correction leaves us with roughly 50 inches of platinum—platinum-rhodium thermocouple wire when the cold junction has reached its lowest point in the thermocouple assembly, the remaining pieces are subsequently welded and reused in another unit.

The spring cord protector at the end of the thermocouple has also a rubber-grommet-type gland which, when tightened, grips the extension lead-wire firmly and prevents strain from being transmitted to the thermocouple assembly. Thus, to make a new hot junction, it is necessary only to loosen the lock nut next to the cord protector, slide enough rubber-covered lead-wire through the thermocouple to expose a new hot junction, make the new hot junction, and retighten the lock nut at the cold end of the thermocouple.

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Fig. 10. Recorder.

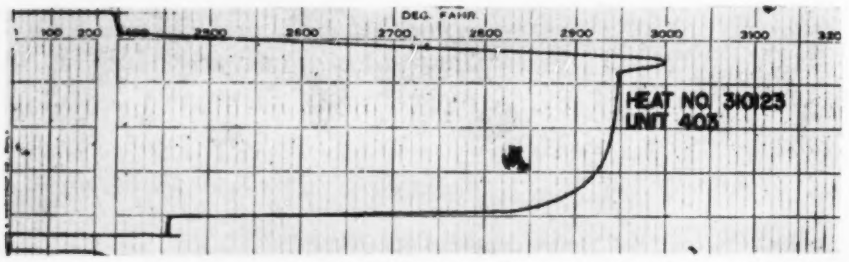
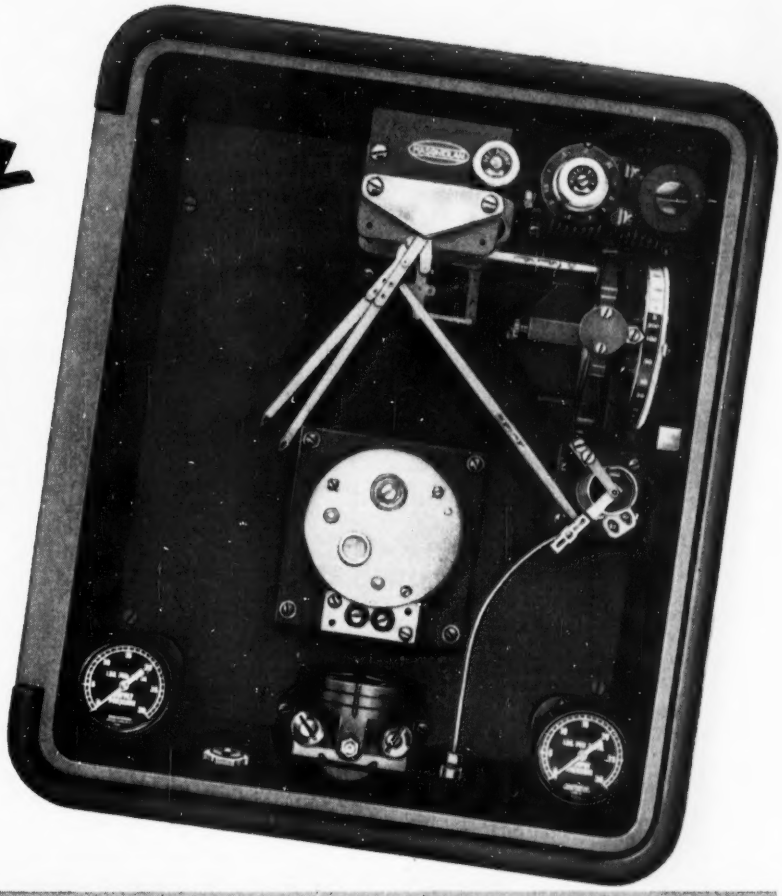


Fig. 11. Typical record.

See it Work in your plant



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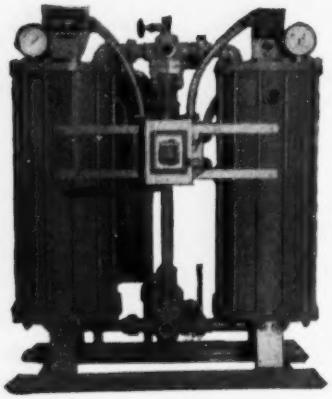
On the Platte Pipe Line...

5 Lectrodryers at Cadoma, Wyoming 3 Lectrodryers at Wymore, Nebraska 1 Lectrodryer at Salisbury, Missouri

DRY air supplied by Lectrodryers* keeps automatic controls awake 24 hours a day



This type of Lectrodryer is used on the Platte Pipe Line; proved dependable in many years of service.

Designers who planned the Platte Pipe Line are taking no chances that moisture will get into instrument air lines and foul up controls. They feed DRY air to their instruments—air dried by Lectrodryers. There'll be no water in their lines to cause freeze-ups, form mud and rust to clog delicate instrument ports.

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In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

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INSTRUMENT SOCIETY of AMERICA Journal

National Office: 1319 Allegheny Avenue, Pittsburgh 33, Pennsylvania

Vol. 9 FEBRUARY, 1953 No. 2

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Section Secretaries, Meeting Data and Programs

AKRON
Russell F. Marquardt, 1782 Tonawanda Ave., Akron 5, Ohio. Tel: ST-6865
Fourth Tuesday, Meeting 8:15 P. M., U. of Akron, Ayer Hall, Rm. 212-B.
March 24, 1953, Industrial Electronics, Speaker from General Electric Company, J. F. Cox

ALBUQUERQUE
C. F. Cox, 209 Gen. Holges, Rd. N. E., Albuquerque, N. M.
Second Thursday, Meeting at 8:00 P. M., Mitchell Hall, Univ. of New Mexico.

ARUBA
M. A. Davidson, P. O. Box 452 c/o Lago Oil & Transport Co. Ltd., Aruba, N. W. I., 2087.
First Tuesday, 7:30 P. M., Engr's Club.

ATLANTA
M. Virgil Davis, 357 Sixth St., N. W. Atlanta, Ga. Tel. EM. 3042
Fourth Friday, Meeting 7:30 P. M., Electric Bldg., Georgia Power Co.

BALTIMORE
G. B. Greer, 631 East 36th St., Baltimore 18, Md. Tel: CHesapeake 6879
Second Friday, Meeting at 8:30 P. M., Engr's. Club of Baltimore.

BATON ROUGE
Thomas J. Folendore, 1540 Reed Avenue, Baton Rouge, La. Tel: 3-5567
First Monday, 7 P.M. Baton Rouge Trade School Winbourne & N. 33rd St.

BLUE RIDGE
David C. Moore, 508 Broad St., Salem, Va.

BOSTON
Robert V. Meyer, Box 111, S. Lincoln, Mass.
Fourth Wednesday, Dinner at 6:30 P. M. Meeting at 7:30 P. M., 99 Club, 99 State St.

CALIFORNIA
Second Wednesday, Dinner at 6:30 P. M. Meeting at 8:00 P. M.
Robert W. Fulwider, 5225 Wilshire Blvd., Los Angeles 36, Calif.

CAROLINA PIEDMONT
L. Frank Lawrence, Minneapolis-Honeywell Regulator Co., 2400 Wilkinson Blvd., Charlotte, N. C., Tel: 5-4422
Second Friday, Dinner at 7:30 P. M., Meeting at 8:30 P. M. Cardinal Restaurant, Charlotte, N. C

CENTRAL ILLINOIS
Thomas A. Carroll, 721 Hurlburt St., Peoria, Ill., Tel: 4-8909
Second Wednesday, Some dinner meetings at 6:30 P. M., Meeting at 7:30 P. M.

CENTRAL INDIANA
Leon Stewart, Rock Island Refining Corp., P.O. Box 6091, Indianapolis, Ind. Tel: CO-2377
First Tuesday, Dinner at 7:00 P.M. Business Meeting 8:00 P.M. McClarney's Famous Restaurant, 1435 West Morris St.
First Tuesday, Meeting at 7:30 P. M.

CENTRAL NEW YORK
C. M. Davies, 213 Beechwood Ave., Liverpool, N. Y. Tel: Syracuse 3-0252.
Third Monday, Dinner 6 P. M. Meeting at 8 P. M. General Electric Auditorium or Solvay Process Library.

CENTRAL OHIO VALLEY
J. C. Dilliner, 813 Winton Ave., Belpre, Ohio. Tel: Belpre 87596
First Tuesday, Dinner at 7:30 P. M., E.S.T., Hi-Way Grille, Rt. #2, about 3 miles south of St. Mary's, W. Va.

CHARLESTON
J. A. Rothwell, 310 24th St., Dunbar, W. Va.
First Monday, Dinner at 6:15 P. M., Meeting at 8:00 P. M., Kanawha Airport Terminal Bldg.

CHICAGO
Floyd E. Ertsman, Rm. 1420, Fisher Bldg., 343 S. Dearborn St., Chicago 4, Ill. Tel: WE 9-0686
First Monday, Dinner at 6:30 P. M., Meeting at 8:00 P.M. Hotel Shoreland, Chicago, Ill.

CHINA LAKE
Beuhring W. Pike, 606-A Essex Circle, China Lake, Calif. Tel: 77782
Third Thursday, Meeting at 8:00 P. M., Michelson Lab., USNOTS, Conference Room.

CINCINNATI
E. J. Geiser, 3666 Hubble Rd., Cincinnati 24, Ohio Tel. Ja. 5618.
First Monday, Dinner at 6:30 P. M., Meeting 8:00 P. M., Engineering Soc. of Cinn.

CLEVELAND
M. M. McMillen, Thompson Products, 2196 Clarkwood Ave., Cleveland, Ohio
Second Wednesday, Dinner at 6:30 P. M. Meeting at 8:00 P. M., Cleveland Eng'r. Society, 2136 E. 19th St.

COLUMBUS
Kenneth I. Lea, Battelle Institute, 505 King Ave., Columbus 1, Ohio Tel: UN-3191, Ext. 247.
Third Thursday, Meeting at 8:00 P. M. Battelle Auditorium

CUMBERLAND
Clyde Babst, 225 Cecelia St., Cumberland, Md. Tel: 583-W
Fourth Wednesday, Dinner at 6:30 P. M., Meeting at 8:00 P. M.

DENVER
Karl F. Kent, Jr., 5030 Umatilla, Denver 11, Colo. No regularly scheduled meetings. Univ. of Denver, Science Bldg.—Campus

DETROIT
R. A. Hoxie, Basic Service Corp., 14016 Woodrow Wilson, Detroit 6, Mich., Tel: TO-88043
Third Wednesday, Meeting 8:00 P. M., Rackham Memorial Bldg., 100 Farnsworth, Detroit, Mich.

EASTERN NEW YORK
Robert W. Carter, Sterling-Winthrop Research Institute, Rensselaer, N. Y. Tel. Albany 5-6251 Ext. 262
First Tuesday, Meeting at 8:00 P. M., Siena College, Loudonville, N. Y. Optional Dinner at 6:00 P. M., Circle Inn, Lathams, N. Y.

FOX RIVER VALLEY
John R. Redgrave, 159 S. Appleton St., Appleton, Wis.

GULF COAST
R. A. Block, 2301 Avenue "G", Nederland, Texas
Last Tuesday, Meeting at 7:30 P. M., Orange County Courthouse, Orange, Texas.

HOUSTON
A. Costa, 714 East 17th St., Houston 8, Texas.
Feb. 23, 1953 Mr. G. E. Heller, Div. Sales Mgr. Taylor Instrument Companies.

KANSAS CITY
Donald D. Baker, 5840 Floyd Ave., Mission, Kansas.
First Tuesday, Meeting at 7:30 P. M., U. of Kansas City, Science Bldg., Rm. 106.
March 3, 1953 "Oil Recorder and Power Plant Instrumentation" by Orval Riggs, Hays Corp.

LAKE CHARLES
A. T. Clinger, Columbia Southern Chemical Corp., P. O. Box 900, Lake Charles, La. Tel. 6-7522
First Wednesday after last Monday, Dinner and regular meetings at McNeese State College

LOUISVILLE
Irving Lefkowitz, 900 Audobon Parkway, Louisville, Ky.
First Monday, Meeting at 8:00 P.M., Seagram Auditorium.

MONTREAL
W. L. Toohey, Dominion Textiles Ltd., 1950 Sherbrooke St., West, Montreal, Tel. GI 5711
Last Monday of Month, Meeting 8:00 P.M., Mechanics Institute

MUSCLE SHOALS
Atherton Hastings, Tennessee Valley Authority, Div. of Chemical Engineering, Wilson Dam, Alabama. Tel: Sheffield 3160, Ext. 6238
First Thursday, Meeting 8:00 P.M., TVA Chemical Engineering Bldg.

NEW JERSEY
Eliot R. Hill, 1125 Kensington Ave., Plainfield, N. J.
First Tuesday, Meeting 8:00 P. M., Essex House Hotel, Newark, N. J.

NEW YORK
R. A. Hutcheon, 45-65 196th St., Flushing 58, N. Y., Tel: BAyside 9-5432
Third Monday, Dinner at 6:00 P. M., Meeting at 7:30 P. M., Midston House, 38th St. & Madison Ave.

NIAGARA FRONTIER
Duran L. Hagler, 214 E. Delavan Ave., Buffalo, N. Y., Tel: ELmwood 1258
Dinner at 6:00 P. M., Meeting at 8:00 P. M., N. Y. S. Technical Institute, 1685 Elmwood Ave., Buffalo, N. Y.

NORTH TEXAS
R. E. Byers, 6000 Lemmon Ave., Dallas 9.

NORTHERN CALIFORNIA
Robert L. Norman, 351 42 St., Richmond, Calif. Tel: BE 2-0901
Third Monday, Dinner 6:30 P. M., Meeting 8:00 P. M. Spengers Grotto, 1919 4th St., Berkeley.

NORTHERN INDIANA
M. J. Duzmal, 10504 Avenue "J", Chicago 17, Ill. Second Tuesday, Meeting at 8:00 P.M., Whiting Community Center, Whiting, Ind.

OAK RIDGE
Thomas M. Gayle, 117 W. Vanderbilt Drive, Oak Ridge, Tenn. Tel: 2-1516.
First Wednesday Meeting at 7:30 P.M., Ridge Recreation Hall

ONTARIO
John W. Huether, 311 Sutherland Dr., Leaside, Ontario, Canada. Tel: HU-7114
Fourth Thursday, Meeting at 8:00 P.M. Friendship Hall, College St. United Church, Toronto

PADUCAH
J. B. Russell, 1407 W. Main St., Murray, Ky.
Second Tuesday, 8:00 P.M.

PANHANDLE
George W. Leggett, 1600 Western Ave., Amarillo, Texas
Third Tuesday in either Amarillo or Borger, Texas

PERMIAN BASIN
J. B. Jenkins, 509 South Ave. "C," Kermit, Texas. Tel: 3220
Second Tuesday, Meeting at 7:30 P. M., Gulf Oil Corp. Auditorium or Odessa College.

PHILADELPHIA
R. A. Trenner, Energy Control Co. Rm. 306, 3147 N. Broad St., Philadelphia 32, Pa. Tel: SA 2-7900
Third Wednesday, Meeting at 8:00 P.M., Bellevue-Stratford Hotel.

PITTSBURGH
Dr. A. H. Peterson, Mellon Institute, 5500 Fifth Ave., Pittsburgh 13, Po. MA 1-1100
Fourth Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Roosevelt Hotel
March 26-27, 1953 Conference: Instrumentation for the Iron and Steel Industry

PRESQUE ISLE
Edwin P. Schuwerk, 445½ Halley St., L. P., Erie, Pa. Tel: 2-2349
Fourth Tuesday, Meeting at 8:00 P.M., G. E. Community Center, East Lake Rd., Erie, Pa.
March 24, 1953 "Servo Control" by Edward Patterson, Bendix Aviation Corp. Eclipse Pioneer Division

RICHLAND
J. R. Plee, 1309 Roberdeau, Richland, Wash. Tel: 5-8692
Second Wednesday, Meeting at 7:30 P. M., American Legion Hall

ROCHESTER
R. C. Schwartz, Jr., Foxboro Co., 1201 Granite Bldg., Rochester 4, N. Y. Tel: Hamilton 1468
March 24, 1953 "Development of Catylitic Cracker Design and Instrumentation" by David M. Boyd, Jr., Universal Oil Products Company
Fourth Tuesday, Meeting at 8:00 P.M., Univ. of Rochester, Physics Lecture Hall

SARNIA
L. J. Hall, 730 Talfourd St., Sarnia, Ont., Canada. Tel: EDgewater 2258.
Third Monday, 8:00 P.M., Y.M.—Y.W.C.A.

SAVANNAH RIVER
F. P. Ledford, Jr., c/o Field Project Manager Ga.,
E. I. du Pont de Nemours and Co., Box 117 Augusta, Ga.

SOUTH TEXAS
Homer C. Givens, P.O. Box 637, Falfurrias, Texas. Tel: 202
First Thursday, Engineers Club

SOUTHERN MICHIGAN
Jack M. Fettig, 433 Thomas St., S.E. Grand Rapids, Michigan.
Fourth Wednesday, 8:00 P. M., Dinner at 6:30 P. M. Meeting at Red Arrow Legion Post, 2431 W. Michigan Ave., Kalamazoo, Mich.

ST. LOUIS
W. G. Lee, 4710 Delor St., St. Louis 16, Mo. Tel: FL 8516.
First Wednesday After First Monday, Meeting at 8:00 P.M., Engineer's Club of St. Louis.

TOLEDO
Howard Daily, 5713 Woodville Rd., Toledo 5, Ohio.
Third Tuesday, Meeting at 8:00 P. M., Service Bldg., Toledo Edison Co.

TENNESSEE
James L. Williams, 2237 Bruce St. Kingsport, Tenn. Tel: 2079-L
February 17, 1953, "Instrument Air Dryers" by George R. Feeley, Trinity Equipment Corp.

TULSA
A. J. Sesock, 845 South East Ave., Tulsa, Okla., Tel: 8-1112
University of Tulsa Campus, Petroleum Bldg.
First Monday, Meeting at 7:30 P.M.

TWIN CITIES
John L. Schmidt, 1879 University Ave., St. Paul 4, Minn., Tel: DR 0064
Fourth Tuesday, Dinner at 6:30 P.M., Meeting 7:30 P.M., Rm. 353, Coffman Memorial Union, U. of Minn.

WASHINGTON
Edward C. Lloyd, 2105 Spencer Road, Silver Spring, Md. Tel: SH. 9340.
Third Monday, Meeting at 8:00 P.M., P. E. P. Co. Auditorium. Subject: "Recent Developments in Instrumentation at the Naval Research Laboratory" by Dr. J. E. Dinger NRL

WAYNE COUNTY
Clarence Ellison, 2443 15th St., Wyandotte, Michigan. Tel: Avenue 2-4178.
Third Monday, Meeting at 8:00 P.M., Larson's Cafe, Lincoln Park, Mich.

WILMINGTON
W. C. Ruglass, 223 Delaware Trust Bldg., Wilmington, Del. Tel: 8-4441
Second Tuesday, 8:00 P.M. Harlan School, 36th & Washington Sts., Wilmington, Del.

Technical Vice-President Brand Reports on Plans for Chicago Conference

The Technical Division met recently to initiate program planning for the 8th National Instrument Conference to be held in the Morrison Hotel, Chicago, Illinois, September 21-25, 1953.

On January 17th and 18th Committees of the Technical Division met at the Commodore Hotel in New York City with P. V. Jones, Jr., Society Manager; C. W. Covey, Chairman and S. D. Ross, Member of the Publications Committee; and Professor R. J. Jeffries, Chairman of the Educational Committee.

In a full day meeting the Committee on Instrumentation for Production Processes, outlined the operation for the oncoming conference. Fourteen members representing ten of the Industry Subcommittees met under the able guidance of C. A. Hansen, Jr., Chairman; and R. N. Pond, Secretary. A report on the impressive amount of business handled by this group is included later in this article.

On Sunday, January 18th, eight of the thirteen Technical Division Chairmen convened to coordinate program and operation. With the capable assistance of C. W. Covey and S. D. Ross a definite step toward early and thorough completion of conference papers was made. The attendance of Professor R. J. Jeffries permitted helpful liaison work which will benefit the operations of both the Maintenance and Analytical Clinics. Some of the accomplishments attained and agreements reached are reported in following paragraphs.

The Committee on Instrumentation for Production Processes has for several years called two meetings yearly; one at the Annual Conference, and one during the following winter. Unfinished business from the September meeting was handled and many new business items were discussed. It is not possible to give a detailed report on all that occurred, but some of the highlights are covered.

The Manual of Operation was reviewed and amended to be compatible with the present mode of operation.

A poll of the Industry Subcommittee Chairmen produced an outstanding list of available papers. Of these, fourteen were selected and will be presented in the five sessions required by the Production Processes Committee.

The methods of preparation, review, and submission of these papers were revised to conform with the requirements of the Publications Committee. The concise definitions of responsibility for reviewing and processing will greatly improve the caliber and presentation of the 1953 papers.

Chairmen and Recorders for the Sessions were tentatively appointed. These will be published in the Advance Tentative Program.

The New Jersey Section represented by Messrs. L. W. Greene, Jr., and C. H. Jones presented plans for the prize contest for ISA Papers. Details are reported elsewhere in this issue.

Meeting of Technical Chairmen

Professor R. J. Jeffries, Chairman of the Educational Committee, went to considerable inconvenience to attend the Meeting of the Technical Division Chairmen. By so doing, however, the inter-committee relations between the Educational Committee and the Committees sponsoring the Clinics were greatly improved. This merging of effort and concept should over a period of years enable the Society to consistently maintain a high standard for its clinics.

C. W. Covey, S. D. Ross, S. G. Eskin, and P. V. Jones spent many hours during the days and evenings of January 17th and 18th to produce a uniform

procedure for handling technical contributions. As a result of the work of these men, there will be in use this year an "A Guide for the Preparation and Presentation of an ISA Paper", and other time saving documents. These same men appeared at the Chairmen's meeting on Sunday, January 18th. The problems of quality control of papers and paper preparation deadline were solved to the agreement of all concerned.

The deadline for final titles, abstracts, speaker's photographs and biographies is March 15th. The deadline for names and photographs of session chairmen and recorders has also been set for March 15th, while the deadline for reviewed final manuscripts is May 15th.

Program planning, insofar as number of sessions is concerned, revealed that known requirements indicate twenty-two sessions on the basis of 1952 operations. At least seven more sessions will be required for the Committees which have not as yet reported.

If one can take as an index the feeling of enthusiasm and cooperation that keynoted the meetings, there can be no question as to the success of the 1953 conference.

Prominent ISA Members to Participate in Educational Conference

The Electrical Engineering Department of Michigan State College, in cooperation with the National Science Foundation, the National Bureau of Standards, the Instrument Society of America, and the American Society for Engineering Education, announces an invitational National Collegiate-Industry-Government Conference on Instrumentation to be held on the campus, March 19-20-, 1953.

Participating in the program will be a number of prominent ISA members. Porter Hart, President of the Instrument Society of America; J. B. McMahon, Past President, R. T. Sheen, Vice President; W. A. Wildhack, Secretary; Educational Committee Chairman Dr. R. J. Jeffries, and members Dr. D. P. Eckman and Dr. H. C. Roberts.

Others participating and representing sponsoring groups will be Dr. Paul Klopsteg, Director of the Mathematical Engineering and Physical Sciences of the National Science Foundation; Dr. A. V. Astin, Director of the National Bureau of Standards, and Dr. E. A. Walker, Dean of Engineering at Pennsylvania State College.

New Jersey Symposium Speakers Announced

The New Jersey Section has announced the speakers for its Annual Conference and Symposium "Management, Labor and the Instrument Department" to be held at the Hotel Essex House, Newark, N. J., April 7, 1953.

Dr. V. L. Parsegian, Research Director, New York Operations Office, U.S. Atomic Energy Commission, will act as Chairman and Moderator.

Mr. T. F. Silvey, National CIO Headquarters, Washington, D. C. will represent Labor. Reverend Dennis Comey, S. J. Director of St. Joseph's College Institute of Industrial Relationships, Philadelphia, will act as a neutral.

For additional information, write N. B. Bartleson, 48 Kempshall Terrace, Fanwood, New Jersey.

RP1.1 Approved

Recommended Practice RP1.1 for the Coding of Thermocouple Wire and Extension Wire has been approved for final printing as of September 8, 1952.

RP1.1 is the first Tentative Recommended Practice of the Society to become an approved Recommended Practice.

Just as soon as it is off the press, it will be distributed to all full members of the Society. Additional copies may be secured at a cost of $.50 to members and $1.00 to all others.

It is with deep regret that the National recently learned of the deaths of John P. Gilmore and David C. Scott. Both men were members of the New York Section.

Third Steel Instrumentation Conference

The Instrument Society of America, Pittsburgh Section, will sponsor jointly with Carnegie Institute of Technology the Third Annual Conference on "Instrumentation for the Iron and Steel Industry", March 26-27, 1953 at the Roosevelt Hotel, Pittsburgh, Pa.

The purpose of the Symposium is to encourage a wider appreciation for and knowledge of instruments in the Iron and Steel Industry. Its aim is to reveal to the man in industry how to improve production by the use of instruments.

Lambert

"Pittsburgh—The City of the Future" will be the subject of the keynote address.

One of the outstanding speakers of the Symposium will be Wm. A. Wildhack, Secretary of the National ISA who is Chief, Office of Basic Instrumentation, Bureau of Standards, Washington, D. C. Mr. Wildhack will talk on "Fundamental Measurements".

The following papers on Instrumentation will be presented and discussed:

"Coke Oven Gas Booster Control"—Frank Revell, Instrument Engineer, Koppers Company.

"Combustion Control for Large One-Way Fired Soaking Pits"—L. F. Kopsa, Assistant Supt., Steam and Combustion, Jones and Laughlin Steel Corp., Pittsburgh Works.

"Controlled Instrumentation in Production of Electrolytic Tinning"—William Smith, Electrical Foreman, Jones and Laughlin Steel Corp., Aliquippa Works.

"Oxygen Control for Blast Furnaces", representative from Weirton Steel Corp., Weirton, West Va.

"Telemetering Applications for Fuel and Power Dispatching Control", representative from United States Steel Corp.

"Instrumentation for Seamless Tubing Production"—Speaker to be announced.

"Instrumentation for Controlled Atmosphere Furnaces"—representative of Electric Furnace Company, Salem, Ohio.

Four papers will be presented on the Basic Open Hearth Instrumentation Panel:

(a) "Automatic Reversal", Frank Hubbell, United States Corp., Homestead Works.

(b) "Preheat Air Temperature Measurement"—representative of Bethlehem Steel Corp.

(c) "Bath Temperature Measurement", representative of United States Steel Corp., Gary Works.

(d) "Roof Temperature Control"—P. J. Webster, National Tube Company, McKeesport, Pa.

The following papers will be presented at the Inspection and Gaging Session:

"Inspection Requirements of Ordnance Contracts"—Speaker to be announced.

"Product Control of Steel"—representative from United States Steel Corp.

"Quality Control—Modern Principles—Progress".—Speaker to be announced.

Those in charge of planning the Steel Conference are Conference Chairman, R. A. Lambert, Supt., Steam Efficiency and Combustion, Jones and Laughlin Steel Corp., Pittsburgh Works; Conference Co-Chairman, L. M. Susany, Chief Engineer, Carnegie Institute of Technology; Program Chairman, Walter N. Flanagan, United States Steel Corp. and Co-chairman, T. W. Marshall.

Headquarters of the ISA Third Conference will be in the Roosevelt Hotel. Room Reservations for the meeting should be made direct by those who plan to attend.

ISA Papers Contest

CASH — CREDIT — FAME — FORTUNE are all yours! Just enter the New Jersey Section Paper Contest . . . You may be the winner of one of the grand prizes.

1st Prize	$100.00
2nd Prize	50.00
3rd Prize	10.00

All you have to do is follow the rules given below. Remember ANY ISA MEMBER CAN ENTER THE CONTEST.

Go to it!

1. This contest is open to any person who is a member of the Instrument Society of America at the time the paper is entered.
2. The paper must be prepared by a single author.
3. The subject must be in the field of instrumentation as applied to process industries.
4. Papers must be original. Papers previously published in any form will not be considered.
5. Papers which review the previously published literature will be considered providing such a study is directed toward a useful and new objective.
6. Four copies of the paper shall be submitted, one of which shall be the original.
7. Papers shall be prepared with a title page listing the following: Title, Author, ISA Section affiliation of author, company affiliation of author and date. No identifying names, marks, etc. are to appear beyond the title page.
8. Papers entered in this contest may also be submitted by the author to the National ISA if so desired.
9. All drawings and/or figures should be done in India ink on tracing paper or a good grade of white paper. All photographs and figures should be clearly and adequately labeled. Photographs should be 8½" x 11" glossy prints. Material should not be clipped from papers, magazines or advertising brochures. All illustrations should be mounted on separate sheets.
10. Full credit for all material quoted from other sources must be given.
11. It is suggested that the entrant clear his paper with his company if so required.
12. The paper should be held to 3,000 words if possible. However, papers as long as 5,000 words will be accepted.
13. No publication commitment should be made by the author of any paper unless approved by the Instrument Society of America.
14. Papers shall be submitted to L. W. Greene, Phelps Avenue, New Brunswick, New Jersey on or before June 1, 1953.
15. Papers will be judged on originality, importance or significance of the idea, organization, clarity and accuracy.
16. All entrants agree to abide by the decision of the judges, which will be final.
17. Prizes shall be awarded in amounts of $100.00 for first, $50.00 for second, and $10.00 for third.
18. Extra copies of these rules for posting, distribution, etc. are available from L. W. Greene, Phelps Ave., New Brunswick, New Jersey.

Prominent ISA Members Participate

The Conference is being called in recognition of the growing importance and potential of instrumentation in research and production, and to the national defense. The objectives of the Conference will be:

(a) To relate the role and needs of Instrumentation in production and research to college interests and responsibilities,

(b) To review current Instrumentation activities in the colleges,

(c) To suggest specific activities the colleges might undertake in this field,

(d) To suggest specific ways by which Industry might assist the colleges in these activities.

Educational and Industrial administrators, and others interested in the field of Instrumentation who would like additional information concerning the Conference should write to Prof. R. J. Jeffries, Department of Electrical Engineering, Michigan State College, East Lansing, Michigan, at once, as attendance will be limited.

Chicago Show a Sellout

The Eighth National Instrument Conference and Exhibit will be the largest ever held. The Exhibit, to be held in the Sherman Hotel, Chicago, September 21-25 is a complete sellout according to Exhibit Manager, Richard Rimbach.

Rimbach

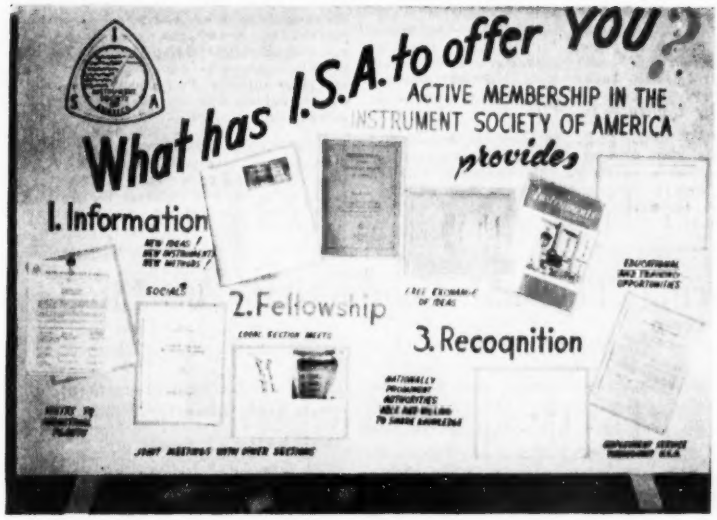
Immediately after the close of the Seventh National Instrument Conference and Exhibit in Cleveland, space reservation forms were sent out to all past exhibitors and over 30,000 square feet of exhibit space was sold.

An additional 4,000 square feet of exhibit space was contracted for, and fewer than 10 booths remain to be sold as we go to press.

The Conference and Exhibit is expected to draw well over 15,000 persons interested in the various phases of instrumentation.

All information concerning the Eighth National Instrument Conference and Exhibit will be detailed in Future issues of the Journal.

Membership Promotion



For increasing your Section's Membership, Baton Rouge Section suggests an attractively displayed bulletin board telling what the ISA means to you. The display board of Masonite panel 4' x 8' has informed many non-ISA members attending Baton Rouge Section meetings as to the importance of belonging to ISA.

This method of membership promotion together with an active Membership Committee has greatly increased the Baton Rouge membership.

ISA EMPLOYMENT SERVICE

Forward your letter to INSTRUMENT SOCIETY OF AMERICA
1319 *Allegheny Ave., Pittsburgh* 33, *Pa.*

JUNIOR INSTRUMENT ENGINEER. For design and application of pneumatic and electronic instruments to textile and chemical industry. Mechanical or Chemical Engineering or Physics degree necessary. Experience desirable. Location: Southwest Virginia. Box 776.

INSTRUMENT MECHANIC. For Southeastern Bleached Kraft pulp mill. Must be experienced in all types process control instruments, including oxidation reduction, pressure, temperature, flow, Baume and pH controls, and powerhouse instrumentation. Box 777.

INSTRUMENT MANUFACTURER'S AGENTS. Wanted by one of the oldest manufacturers of industrial and dial thermometers, recorders, controllers, viscosimeters and manometers. Excellent commission with exclusive territory which will be made available to qualified men in this field. Box 778.

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PROJECT ENGINEER (ELECTRONICS). A qualified professional engineer, possessing a Bachelors degree or equivalent in the fields of engineering or science, and having had six years or more experience in the field of electronics; is responsible for an engineering project or projects under the direction of a Supervisory Engineer or the Chief Engineer; may act as Assistant to a Supervisory Engineer in coordinating engineering phases of several projects, including the efforts of other engineers, physicists, technicians, etc.; assumes minor administrative duties, and is responsible for directing preparation of specifications, proposals, reports, etc. in connection with the completion of the projects assigned. Age: Open. The starting salary we can offer for this position will depend entirely upon the individual's background of education and experience, and may fall anywhere between $465 and $625 per month, plus a quarterly cost of living allowance. Location: Cincinnati, Ohio. Box 780.

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Apparatus for Measuring Thermal Conductivity of Liquids

By H. L. MASON*

Abstract. Constructional and operating details are given for an improved apparatus for measuring thermal conductivity of non-metallic liquids at 0 to 100 deg. C. The test layer is a long cylinder of narrow annular section. The test cell is designed to allow only small thermal losses, so that high accuracy in absolute measurement is expected.

THE thermal conductivity of liquids has long interested physicists as a characteristic property which might shed light on the structure of matter, and has more recently been needed by engineers for designing heat-transfer equipment.

From the results of previous investigators, (see below) it is known that the value of thermal conductivity at room temperature and atmospheric pressure is about 1440 for water, about 680 for glycerol, from 360 to 500 for other alcohols, and from 290 to 430 for common oils and solvents, in units of 10^{-6} cal/(sec-cm-°C). Air, in comparison, runs about 60; metals range from 70,000 to 920,000.

For any one liquid, however, values disagree by anywhere from 3 to 20 per cent. Few data are available for other temperatures, and on some liquids there is disagreement as to whether the temperature coefficient is positive or negative.

Accordingly, a project was set up in the Iowa Engineering Experiment Station with the aim of getting values for technically important liquids to an accuracy of 1 per cent for the range 0 to 100° C. The apparatus to be described is limited, however, to liquids which flow readily at these temperatures, and which will not attack copper, solder, or Teflon. Their electrical conductivity is unimportant.

History of Previous Work

Summaries of earlier investigators have been made by Jakob[1] (1920), Smith[2] (1930), Eucken[3] (1940), and Riedel[4] (1940). In the last 20 years, experimenters with non-metallic liquids have used five shapes of specimen: the small-diameter cylinder, the large-diameter cylinder, the thin horizontal sheet, the thick horizontal layer, and the thin annular film.

With the small-diameter cylinder, contained in a metal or glass tube, heat is supplied by current in a wire stretched along the axis, and flows steadily outward to the tube, which stands vertically in a thermostatted bath. Wire temperature is computed from its electrical resistance. Kardos[5] (1933) used a 1.66 mm silver tube and a platinum wire of 0.1 mm diameter. Hutchinson[6] (1945) used a cm Pyrex tube and a 0.088 mm tungsten wire.

A method based on the rate of temperature rise in a suddenly heated wire, stretched vertically in a large-diameter cylindrical specimen, was developed by Stalhane and Pyk[7] (1931) and rediscovered by Pfriem[8] (1938). Weishaupt[9] (1940) constructed a glass cell 6 cm in diameter by 30 cm high, with a 0.07 mm gold wire. Another made by van der Held and van Drunen[10] (1948) had a 0.3 mm manganin heater with attached thermocouple, both encased in a glass capillary, which permitted immersion in acid and salt solutions.

Martin and Lang[11] (1933) worked a circular sheet of water 1.07 mm thick, heated from above. Surface tension was relied upon to prevent side leakage. Riedel[4] (1940) shrouded his pancake heater completely in a 1 mm sheet of liquid. Bates et al.[12] (1938-1945) used a thick layer, adjustable from 0.125 to 4 inches, heated from above, surrounded by a guard heater, and probed by movable thermocouples actually immersed in the test liquid.

A test cell developed by Bridgman[13] (1923) had a heater cylinder 0.375 inch in diameter surrounded by an annular liquid layer 0.016 inch thick by 1.25 inches long, the ends being closed by german-silver foil. This cell was used by Smith (1930[2], 1936[14]) and by Daniloff[15] (1932). The annular geometry, with liquid surrounding heater ends as well, was obtained by Schmidt and Sellschopp[16] (1932), using dimensions of 30 by 120 by 0.5 mm. Riedel (1940[4], 1949[17]) constructed similar apparatus, with a fully immersed heater and layer dimensions of 28 by 60 by 1 mm, for comparative measurements on viscous, acid, or fatty liquids.

Description of Test Cell

It was decided to adopt the thin (about 0.016 inch) annular layer of liquid as the test specimen, but to make it relatively long (about 5 inches) and to use non-metallic closures and fine lead-in wires to reduce thermal end effects. Fig. 1 shows the upper end of the test cell.

Liquid layer *(1)* surrounds a heater cylinder *(2)* of polished but tarnished copper. Its diameter is 0.3743 inches, measured at 21 points with an estimated accuracy of five digits in the fifth place, and a range from 0.3740 to 0.3749. Its length is 4.995 inches, measured at four points with an estimated accuracy of 0.0003 inch and a range from 4.990 to 5.000 inches.

The single-wire heater is 0.004-inch enamel-covered Nichrome V, made one per cent longer than cylinder *2* to provide extra energy for heat loss at either end. Its voltage leads are 0.0045-inch copper butt-joined under a microscope by silver solder (No. 151 Eutectoid with No. 151 flux) in powder form, and re-insulated with several coats of varnish G-E No. 7049, air-dried and baked.

Current leads of 0.026-inch copper are attached 2½ inches from the resistor wire, which is drawn through 0.020-inch bore *(9)* in 0.125-inch copper capillary *(8)*. This capillary, a push fit in *2*, has its end turned concentrically with the O.D. of *(2)*.

Over this fits closely the central hole of a 0.005-inch thick Teflon disc *(7)* which serves to seal the annulus, to hold *2* central, and to support it axially. The disc is clamped under heater cap *(6)*, whose inner face is circumferentially grooved, the whole being held by four No. 1-72NF cap screws *(5)*. The lower end of cylinder *(2)* is similar.

Receiver Cylinder Around Heater Cylinder

Receiver cylinder *(3)* is a 1.125-inch diameter copper rod with a polished but tarnished bore of 0.4084 inch measured at 24 points with an estimated accuracy of 0.0001 inch and a range from 0.4077 to 0.4107 inch. Between

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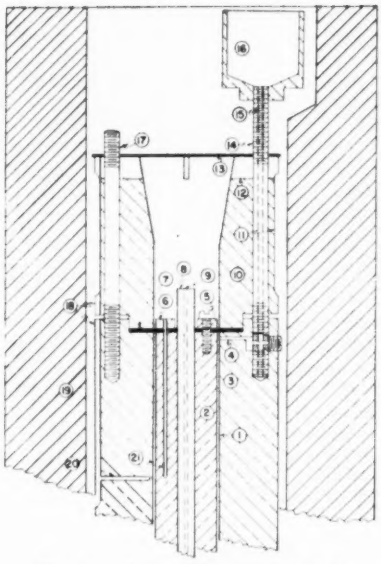

Fig. 1. Upper End of Test Cell

the 0.688-inch counterbores, which seat and center the Teflon disc *(7)*, its length is 5.0003 inches, measured at four points with an estimated accuracy of 0.0005 inch and a range from 5.0002 to 5.0005 inches.

Receiver cap *(10)* of copper, held by four 0.125-inch copper studs, presses a circumferentially grooved face against disc *7* and completes the closure. The lower end of *3* is similar, except that cover *13* is omitted.

Before the annulus is filled with test liquid, air is removed through opening *4* into hollow stud *14*, whose upper end receives at *15* a tapered fitting connecting with the vacuum pump. This joint can be flooded with test liquid in cup *16*. A similar cup and filler tube, not shown, lead to the bottom of the annulus.

This tube is closed by a taper pin during evacuation; pulling the pin releases the liquid charge into the annulus. The vacuum connection is broken manually as soon as liquid rises into the evacuation tube. Only about two cc of test liquid is required to fill the cell and its connections.

Location of Thermocouples

The temperature difference between heater and receiver cylinders is measured by copper-constantan thermocouples of 0.0045-inch enamel-covered wire inserted into 0.031-inch drilled well *(20* and *21)*. Extension wires from the latter, also those from the heater, are carried by spaghetti through three slots *(12)* into a tape-wrapped annular recess *(11)*.

Extension wires from *20* are brought out in grooves *18* to join them, and all remaining junctions are made there and held by tape in close thermal contact with copper cap *10*. Junctions are made with silver solder, and the thermojunctions in *20* and *21* are re-insulated with several coats of varnish G-E No. 7049, air-dried and baked. This stiffens them enough to permit their being pushed to the bottom of a well, where they are held by a touch of water-putty at the entrance.

There are four such pairs of thermojunctions, two located at opposite sides of the test cell 1.25 inches below the upper end of the annular liquid layer, and two 90° away from these and 2.5 inches below them.

Constant-Temperature Bath

At any given temperature level, it is essential that temperature variation of receiver cylinder *(3)* and its caps *(10)* be held to a minimum. This is accomplished in an eight-gallon insulated bath of mineral oil, cooled by dry ice or heated by electrical resistors with external current control. Manual adjustment provides an approximate balance between heat supply and loss, and the last few watts are automatically controlled by a mercurial thermoregulator with a sensitivity of 0.01° C.

The oil is circulated downward at the bath center and upward at the periphery. Immersed in it is a steel lag cylinder *(19)* with 2.50-inch O.D. and 1.25-inch bore into which receiver cylinder *3* is pushed. Only the filling and evacuating cups protrude, and these are covered to protect them from air currents in the room.

Close thermal contact between *19* and *3* is assured by four channel-shaped strips of spring copper which extend the whole length of *3* and hold it in the bore by friction. After a change of heater input, a change of thermocouple emf can be noted at once, but from 20 to 40 minutes are required to reach thermal equilibrium, as evidenced by substantially constant readings of temperature difference.

Measuring Circuits

Measurement of heat input and of temperature difference is made by the circuits of Fig. 2. Here the three-watt Nichrome heater is shown in heater cylinder *(HC)*, with current supplied by a six-volt storage battery through an adjustable resistor and an ammeter *(A)* readable to 0.5 per cent. Voltmeter *V* indicates to 0.3 per cent the voltage drop across the Nichrome plus five inches of 0.0045-inch copper, computed corrections of about 2 per cent being made for resistance of the latter and for that of the voltmeter.

The four pairs of thermojunctions in parallel between *HC* and receiver *RC* automatically average the emf's they generate, because each has the same length of high-resistance (constantan) circuit. Because of the small size of wire, standard values of thermoelectric power could not be used, and two standard couples were made up from the same spools of wire as the working couples, with doubled copper and quadrupled constantan elements.

The assembled couples were examined for inhomogeneity by means of a sharp temperature gradient, and the stray emf was found to be less than one microvolt. They were then calibrated at 30.65 and 60.35° C against a resistance thermometer, a Mueller bridge readable to 0.0001 ohm, and a White potentiometer readable to 0.01 microvolt. Another calibration point was a steam bath at 99.15° C. They agreed to 0.1 per cent, and a least-squares determination yielded the relation

$$dv/dt^* = 34.385 + 8.246 \times 10^{-2}t - 0.774 \times 10^{-4}t^2$$

This is about 10.6 per cent below the values of R. B. Scott[18] for larger wires.

Since extreme precision is sought in making a temperature-difference measurement of 0.500° C (about 19 microvolts), special precautions are taken to avoid spurious emf's. Moving copper contacts are arranged to wipe off the oxide which could feed in recti-

*Microvolts/deg C

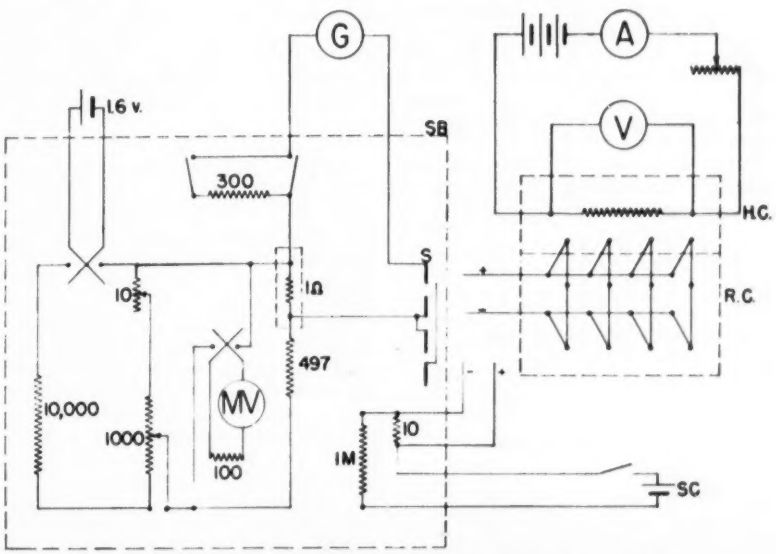

Fig. 2. Circuits for Heating and Temperature Difference

fied a-c picked up from a 5000-watt broadcasting station less than half a mile away. Soldered joints in twin conductors are either placed close together or in close contact with a good thermal conductor, in the hope of cancelling whatever thermoelectric effects they may introduce.

Details of Switch Box

From recesses *11* in Fig. 1, where the four pairs of thermocouple leads are joined, unbroken copper wires of 0.026-inch diameter lead to the enclosed wooden switch-box *SB*. Reversing and disconnect switch *S* inside the box has four contacts, consisting of four copper connection wires pushed by springs against a massive cellophane-insulated copper bar. The incoming wire ends are slid perpendicularly under these, affording self-cleaning point contact.

In series with the contacts is a 1.0037-ohm resistor, housed with its soldered connections in a massive copper cylinder, also a mirror galvanometer. The latter, mounted about 10 feet away, is used as a null indicator. Its leads are stranded copper lamp cord, intertwined. Its internal resistance is 36 ohms; its external critical damping resistance, 310 ohms; its period, 4.9 seconds; its voltage sensitivities, 2.4 and 0.36 microvolts per mm, course and fine respectively.

Opposed to the thermocouple emf across the 1.0087-ohm terminals is the voltage from the multiplier circuit[2], originating in the 1.6-volt instrument dry cell, adjusted by coarse and fine wire-wound rheostats, and measured by the millivoltmeter to 0.1 per cent, after multiplication by the factor 498.14/1.0087. Both the multiplier resistors are manganin.

To minimize stray emf's in the galvanometer and its leads, no damping resistor is used. A quick check on the entire *SB* circuit is provided by the reduced potential from the standard cell *SC*. All thermocouple readings are averaged by applying emf to *SM*, first in one direction and then in the other.

Heat Flux Due to Conduction and Connection

The heat flux due to conduction across a thin annular layer is given in calories per second by

$$q = \frac{2\pi Lk(\Delta T)}{\ln r_o/r_i},$$

where

k = conductivity, cal/(sec) (cm²) (deg C per cm)
r_o, r_i = outer and inner radii of annulus, cm
L = axial length, cm
ΔT = temperature difference between r_o and r_i, deg C

A small correction is needed to reduce the apparent q, obtained from the corrected electrical input, because of heat conducted away from the heater cylinder through Teflon discs, heater leads, and thermocouple leads. One disc provides a path with area 1.27 mm × 0.99π cm, gradient 0.5° C in 3.92 mm, and conductivity 0.58 × 10^{-3} cal/(sec) (cm²) (deg C per cm), losing 1.2 milliwatts.

Each end of the heater cylinder carries three leads of 0.0045-inch diameter copper and one of constantan, with lengths of at least 3 cm before they touch the cool receiver cylinder. Since the exact temperature of the heater wire is uncertain, the average gradient is conservatively estimated at 0.5° C in 1 cm, which with conductivities of 925 × 10^{-3} and 60 × 10^{-3}, gives a loss of about 0.6 milliwatts.

Convective transfer through the dead air space above and below the heater cylinder is negligible in comparison, using[19] the coefficient 0.38 *(T)* 0.25. Thus the total end loss does not exceed 0.5 per cent for most nonmetallic liquids, and is only 0.1 per cent for water.

Convective transfer across the test liquid is negligible, even for ethyl ether, which has a Grashof-Prandtl product

$$\frac{\delta^3 g\beta.\Delta T}{(\mu/\rho)^2} \cdot \frac{c\mu}{k} = 20$$

for this apparatus. A product Gr • Pr <1000, with δ = annulus width, was found by Kraussold[20] to reduce convection to 2 per cent, and this finding was confirmed by van der Held and van Drunen[10]. Additional evidence is offered by Hutchinson[6] and by Riedel[4], who found that similar tall vertical elements showed no change in conductivity readings even when tilted nearly horizontal.

Heat Flux Due to Radiation

Radiation transfer across the annular liquid layer is more difficult to evaluate, because of the lack of experimental data. If we assume the confining walls are gray surfaces of 293° K and 292.5° K, separated by a non-absorbing medium, the heat flux is given in dyne—cm/sec by

$$\sigma A_1 F_{12} (T_1^4 - T_2^4)$$

where A_1 = area in sq cm
F_{12} = form factor
σ = Stefan-Boltzmann constant

The form factor F_{12} is about 0.9 for long narrow rectangles with emmissivity of 0.1 as a generous estimate for tarnished copper.

The heat flux due to radiation is, calculated to be 0.6 milliwatts, but rises to twice that at 373° K and 372.5° K. However, there is little likelihood that a liquid layer will transmit this without considerable absorption. It is known that even the vapors of water, hydrocarbons, and alcohols show appreciable absorption bands at furnace temperatures. Jakob[21] mentions a metallic sheet with absorptivity of 5.8 per cent which was increased to 75 per cent by a layer of "oil" only 5 mils thick. Everything considered, it seems advisable to follow Bridgman[13] in ignoring any correction for radiation transfer.

Correction for Temperature Difference

Another small correction should be made to account for the temperature difference between the inner boundary of the liquid layer and the corresponding thermojunction. The junction may be assumed to come reasonably quickly to the temperature of the copper in the heater cylinder at a radius r_j = 0.125 inch, since it is "immersed" in a well for a length of 1.25 inches, and no readings are taken until the millivoltmeter indicates a constant value.

However, a small temperature difference is necessary to maintain flux q radially through the copper to the liquid specimen. This can be computed from

$$\Delta T = \frac{q \ln r_i/r_j}{2\pi LK},$$

and amounts to 0.004° C for water, and about 0.001° C for most nonmetallic liquids. The millivoltmeter scale values can be estimated with a precision equivalent to 0.0005° C; and the galvanometer null, to 0.001° C.

It is concluded that this apparatus may be expected to give absolute values of thermal conductivities of not too viscous, noncorrosive, nonmetallic liquids at ordinary temperature, to a high order of accuracy.

BIBLIOGRAPHY

1. M. Jakob, Annalen der Physik, ser. 4 **63**, 537 (1920).
2. J. F. D. Smith, Ind. & Eng. Chem. **22**, 1246 (1930).
3. A. Eucken, Forschung Ingen-wes. **11**, 6 (1940).
4. L. Riedel, Forschung Ingen-wes. **11**, 340 (1940).
5. A. Kardos, Zeit. VDI. **77**, 1158 (1933).
6. E. Hutchinson, Trans. Faraday Soc. **41**, 87 (1945).
7. Stalhane & Pyk, Teknish. Tidsk. (1931).
8. H. Pfriem, Zeit, VDI, **82**, 71 (1938).
9. J. Weishaupt, Forschung Ingen-wes, **11**, 20 (1940).
10. E. F. M. van der Held, F. G. van Drunen, Proc. 7th Int. Congress Appl. Mech. **3**, 79-90 (1948).
11. L. H. Martin, K. C. Lang, Proc. Soc. Lond. **45**, 529 (1933).
12. O. K. Bates et al., Ind. & Eng. Chem. **25**, 431 (1933); **28**, 494 (1936); anal. ed. **10**, 314 (1398); 33, 375 (1941); **37**, 193 (1945).
13. P. W. Bridgman, Proc. Am. Acad. Arts & Sci. **59**, 241 (1923).
14. J. F. D. Smith, Trans. ASME, **58**, 719 (1936).
15. M. Daniloff, Jour. An. Chem. Soc. **54**, 1328 (1932).
16. E. Schmidt, W. Sellschopp, Forschung Ingen-wes. 3, 277 (1932).
17. L. Riedel, Chemik. Ingen. Tech. **21**, 340 & 355 (1949).
18. R. B. Scott, p. 211, Temperature Symposium, Amer. Inst. Phys., Reinhold, New York (1941).
19. W. H. McAdams, Heat Transmission, ed. 2, McGraw-Hill, (1942).
20. H. Kraussold, Forschung Ingen-wes. **5**, 186 (1934).
21. M. Jakob, Heat Transfer, vol. I, Wiley (1949).

Aircraft Cabin Temperature Control Systems

Control problems in aircraft with conventional space temperature control applications and reviews history of early control systems in aircraft including advent of pressurized cabins and jet transports. Basic control applications and their problems are then discussed followed by descriptions of basic circuits and control equipment. Factors for emphasis in design are then considered, concluded by a brief prediction of trends in these control systems.

By SECOR D. BROWNE*

Introduction

Similarity and dissimilarity between aircraft cabin temperature control systems and conventional space temperature control applications. Similar in standards of comfort and theory of application. Dissimilar in wide and rapid fluctuations of load and the equipment controlled.

THE primary purpose of a temperature control system is the same for the cabin of a million-dollar transport airplane as it is for any air-conditioning system namely: occupancy comfort. Within the capacity and limitations of the heating, ventilating, and/or air conditioning system, it is the function of the automatic controls to maintain temperature at a level which will satisfy as many of the occupants as possible. The basic axioms of temperature control remain the same. The temperature sensitive device or thermostat must inevitably be installed in a compromise location which, it is hoped, will represent an average of conditions in the controlled space or zone.

Much of the success of the temperature control system will depend on whether a good compromise or a bad one has been made. Control from a thermostat located over restaurant coffee urns of from a temperature sensitive resistance element located in a return air duct from a lighting trough in the cabin ceiling will be equally unsatisfactory.

Similarly, proper and adequate air distribution is essential if any thermostat is to sense and control. Careful zoning of an air conditioning system will greatly influence successful operation of the temperature control system. The difference in exposure and load between aircraft cockpit and cabin should be as obvious as the difference between a restaurant's cooking and dining areas and the need for zoning, equally apparent.

Finally, a temperature control system can neither be expected to supply heat beyond the capacity of the steam coil in a commercial air conditioning unit or the sum of the heat from the aircraft superchargers and combustion heaters nor to extract heat beyond the capacity of a cooling coil or an air expansion turbine. These are certainly very elementary principles of temperature control application. Perhaps it is their familiar simplicity that leads them so often to be ignored.

Differences Between Aircraft and Conventional Controls

The dissimilarities between aircraft temperature control systems and conventional control systems are largely a matter of degree. The "skin" temperature of a building can be expected to vary, seasonally, from 0 to 10 degrees below zero to 90 or 100 degrees above zero, and the air velocity over the skin may range from 15 to 20 miles per hour. The "skin" temperature of an airplane can vary, from well below zero to 200 or more degrees above zero, and air flow over the skin can reach, or exceed, the speed of sound.

For present commercial transport aircraft air velocity over the skin will probably not exceed 300 to 400 miles per hour, but skin temperatures can be as low as 80 degrees below zero. Wide fluctuations in skin temperature and air flow velocities are not necessarily seasonal but can occur in a matter of minutes, so that an air conditioning system for the comfort of aircraft passengers must have far greater capacity than a system designed for the comfort of the same number of people on the ground.

Rapid response is not only a function of the capacity of the air conditioning equipment but an important characteristic of any satisfactory aircraft cabin temperature control system. It is the need for rapid response which has led to the general acceptance of the temperature sensitive Wheatstone bridge as the basic temperature control circuit for aircraft applications.

The insignificant mass of temperature sensitive elements, used with sensitive amplifiers, combines rapid response with great flexibility for anticipating, resetting, and averaging control. The relatively high cost of this type of control equipment in comparison with conventional temperature controls is not a significant factor in contrast to the considerations of response, flexibility, weight, space, and reliability under the most adverse environmental conditions.

"All Year Round" System Required.

The design of the *controlled* equipment in the aircraft cabin system is largely dictated by considerations of weight, space, and available sources of energy, in addition to performance, and is, of course, reflected in the design of the cabin temperature control equipment. For aircraft operating at altitude, the heat from engine-driven cabin superchargers supplemented by gasoline-fired heaters or exhaust gas heat exchangers supplies cabin heat.

In the case of jet aircraft cabins, heat can be supplied by air bled from the jet engine. Unpressurized aircraft depend on exhaust gas heat exchangers or combustion heaters for cabin heat. Considerations of weight and space have overcome most objections to the inefficiency of the air cycle system for cabin cooling although one of the best known postwar commercial transports employs a direct expansion Freon system.

In the continuous regulation of this equipment from full cooling through full heating, the aircraft cabin temperature control system does not depart from the basic principles of any "all year 'round" temperature control system, although obviously the circuitry is different and the physical appearance of the aircraft control components differs radically from conventional temperature control equipment.

*Clifford Manufacturing Co., Division of Standard Thomson Corporation, Waltham, Mass.

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History and Development

Beginnings of automatic cabin temperature control in early flying boats and transport aircraft. The first pressurized airplanes. Later automatic cabin temperature control systems in unpressurized and pressurized aircraft. Control of cabin temperatures in jet transports.

The evolution of aircraft cabin temperature control dates back at least 20 years. Prior to the advent of the closed cabin and the development of the exhaust-gas-to-air heat exchanger, passenger flying was not practical in winter. The use of an exhaust gas to air heat exchanger, however, introduced a safety system as well as a control system. One of the early four-engine flying boats, the Boeing 314, had a carbon monoxide detector electrically connected in the temperature control system so that in the event of dangerous carbon monoxide concentration the heat exchanger was completely by-passed and all ram air supplied to the cabin.

This carbon monoxide detection system alone out-weighed the complete heating system of many equivalent-sized modern aircraft. The temperature control system employed a thermostat to position motor-operated dampers (air valves in aircraft parlance) and regulate the flow of ram air through or around the heat exchanger. The control equipment was essentially a direct current version of a conventional proportioning commercial control system and weighed almost as much.

The danger from carbon monoxide contamination by a faulty heat exchanger was obviated in the design of the Douglas DC-3 which was heated by an exhaust gas flash boiler, generating steam for a coil in a ram air duct supplying the cabin. Damper valves were manually positioned to control the mixture of heated and by-passed air.

The problems of keeping the heating system operative at all distracted the airlines from the increased comfort possible through automatic temperature control. Although several airlines modified their boiler installations to include cabin temperature control, most of the systems were manually operated until after the last war when many DC-3 heating systems were converted to automatically controlled gasoline-fired combustion heaters.

Early Temperature Control Systems

The Vought-Sikorski 44-A flying boats built shortly before the last war were equipped with an exhaust gas heating system and a cabin temperature control system which were improved versions of predecessor equipment and still incorporated carbon monoxide detection as part of the temperature control system. In the years between the design of the Boeing 314 and the Vought-Sikorski 44-A, gasoline-fired combustion heaters had been developed to the point where they were specified for the twin-engined transport which became the war-time C-46 (Curtiss-Commando).

Automatically controlled combustion heaters supplanted exhaust gas heat exchangers and boilers for the design of the Douglas DC-4 and of many war-time military aircraft. The application of cabin temperature control changed from the task of gradually positioning dampers which maintained a suitable mixed air temperature to the problems accompanying control of a large and almost instantaneous source of heat energy.

Attempts to proportion or modulate the supply of gasoline as a means of controlling the output of aircraft combustion heaters have been largely unsuccessful. After many tests the current practice was adopted of cycling the heater as rapidly as practical. This practice places a premium on the rapid response of whatever temperature control is used to cycle the heater, especially with combustion heater ratings of as high as 300,000 btu/hr.

Advent of Pressurized Cabins

Although the pressurized Boeing Stratoliner was in operation before the war, the war-time concentration of long-range high altitude military aircraft gave impetus to pressurization of aircraft and greatly complicated the heating, cooling, and ventilating systems for aircraft cabins and their attendant temperature control systems. Pressurized aircraft designed for post-war airline service (such as the Lockheed Constellation, Douglas DC-6, Convair 240, Boeing Stratocruiser, and, in Canada, the Canadair DC-4-M-2) included completely automatic cabin temperature control systems to operate the complete air conditioning cycle from full cooling through full heating with a sequence of electrically interlocked temperature sensitive Wheatstone bridges.

Some of the operating airlines felt that a heavy penalty was thus paid in complexity and maintenance difficulties for a degree of automatic operation which was unnecessary. Most of the cabin air conditioning systems have been modified by the airlines with a view of simplification, which—although imposing a certain amount of manual control as a matter of normal, not emergency, procedure—is an effort to reduce maintenence trouble at the expense of more precise, completely automatic temperature regulation.

It is anticipated that cabin temperature control in jet transport aircraft will be similar in operation to existing systems; the CF-102 jet transport manufactured by A. V. Roe, Canada, has been designed to incorporate just such a conventional aircraft control system with minor modifications.

Basic Applications

Control of exhaust gas to air and steam to air heat exchangers for cabin heating. Combustion heaters. Engine driven superchargers and jet engine bleed as a source of cabin heat. Direct expansion and air cycle refrigeration systems for cabin cooling and their controls. The ventilation cycle. Full sequence cabin temperature control, cooling-ventilation-heating. Effects of air volume, velocity, and distribution on performance of cabin temperature control systems.

The exhaust gas heat exchanger is still in use for the heating of cabins of small private aircraft and in these applications the heat supply is controlled by manually positioning a damper valve through a mechanical linkage to regulate the volume of heated air to the cabin. One of the post-war airline transports utilizes exhaust gas heat exchangers as a source of cabin heat in a system of primary and secondary heat exchangers.

This system minimizes the possibility of exhaust gas contamination of the cabin air supply and eliminates the bulky and heavy carbon monoxide detectors incorporated in the control systems of earlier exhaust gas heated aircraft. Control of the exhaust gas heat exchanger is part of the automatic control sequence which operates the air conditioning system from full refrigeration through full heating, the cabin air supply being valved to pass through or around the secondary heat exchanger in proportion to the demands of the temperature control system.

Maintenance and material difficulties have led to the substitution of combustion heaters for steam to air heat exchangers in many of the pre-war transports still in use and have prevented their use in post-war transport aircraft. Those systems still in operation largely retain the original manual controls.

Problem of Combustion Heater Control.

The combustion heater presents a dual control problem, namely: (1) the basic primary control system of the heater which includes the ignition, fuel, and safety controls, and (2) the secondary control system which cycles the heater to meet the cabin heating requirements. The very rapid response of so large a source of heat as a combustion heater puts a premium on extremely rapid response of the duct temperature control system particularly since, as noted earlier, this type of heater must essentially be operated as an "on-off" device and cannot be adjusted directly to proportion or modulate its output.

In pressurized aircraft, the heat of compression from engine-driven superchargers, or of the air bled from a jet engine for cabin pressurization, is available as a source of cabin heat. Leaving the supercharger, the pressurized air passes through an aftercooler which is a heat exchanger using ram air in its secondary side to remove heat from the hot supercharged air in the primary side.

The cabin temperature control system positions a valve to regulate the

flow of secondary ram air and thus control the quantity of heat remaining in the supercharged air supplied to the cabin. If the temperature of the cooled supercharged air remains in excess of cabin requirements, the air must then be valued to pass through the refrigeration unit before reaching the cabin.

Refrigeration Systems

Weight has been a major factor in the favor shown the air cycle or air expansion turbine refrigeration system over the aircraft version of the direct expansion refrigeration system, the difference in weight being on the order of 3½: 1. Control of the direct expansion system in aircraft has been by step control of compressors and unloaders to meet control system demands. The air cycle system is controlled by a valve system which supplies or by-passes the turbine and heat exchanger and thus achieves proportioning or modulating control of refrigeration within the design limitations of the cooling package.

In many installations there is the added complexity of a low limit control which overrides the cabin control when the temperature of the air leaving the air cycle unit approaches freezing. The air cycle unit does not remove moisture from the air except by the addition of mechanical separators or screens. Sub-freezing discharge temperatures can result in snow or fog in the cabin or block the duct by freezing the water adhering to the separators.

When the aircraft is operating at altitude where pressurization is not required, the cabin air supply can be taken directly from ram air and heated, cooled (with a direct expansion system), or used at ambient, as dictated by the cabin temperature control system. If the aircraft is fitted with an air cycle unit, refrigeration will not be available on ram air since the amount of energy necessary to operate the air expansion system must be provided by a supercharger or by bleed from a jet power plant.

Function of Cabin Temperature Controls.

It is the function of the cabin temperature control system to coordinate the operation of the aircraft's sources of heating, cooling, and ventilating in a control sequence which will, under any given flight conditions, and within the capacity of the equipment, maintain cabin temperature consistently at a selected level. It is possible to make this control sequence fully automatic by electrically inter-locking valve actuators and other control components. Cabin temperature control systems for post-war transport aircraft were initially so designed.

Assuming a pressurized transport flying at altitude under conditions requiring full heat: the cabin controls would call for rapid cycling of the combustion heater, no ram air would be supplied to the secondary of the aftercooler, and the refrigeration unit would be completely by-passed.

Assuming flight conditions to change gradually to the point where full refrigeration was required: the cabin control would cease to cycle the combustion heater, control action would then pass to the actuator positioning the aftercooler scoop valve to allow a gradually increasing flow of secondary air. This would increase the amount of heat extracted from the supercharged primary air. Finally, control action would be transferred to the actuator operating the refrigeration by-pass valve until full refrigeration capacity was being used.

The control sequence could, of course, stop at any point where the demand of the cabin control system was satisfied; or it could reverse the sequence, as demanded by changing flight conditions. As outlined, the control sequence does not sound particularly involved, but in fact is much more complicated since there would normally be other control units to be operated in parallel or in sequence to control various zones or to provide for other requirements such as windshield defogging and anticing.

Development a Matter of Coordination.

The degree to which the temperature control sequence is made automatic without the intervention of the flight engineer to make manual adjustments and control transfers is a matter of coordination between the operating airlines, the airframe manufacturers, and the suppliers of control equipment.

The design of any aircraft appears to be a struggle for a sort of technical "lebensraum" between the different engineering groups, any one of which feels the entire cubic content of the airplane to be barely adequate for its particular specialty. The space finally allocated to the temperature control components may be barely adequate for their bulk, much less their function.

This does not make it any less necessary for the temperature sensing elements to be installed where they will be continuously exposed to air at a volume, a velocity, and a temperature combined to make it a representative sample of the condition which it is desired to maintain. This point is stressed again primarily because re-location of equipment in an already crowded airframe is, at best, difficult and, at worst, impossible, yet often may be the only method of obtaining satisfactory cabin temperature control in an existing airplane.

Basic Circuit and Control Equipment

On-off controls. Types of thermostats. Proportioning (modulating) systems. The temperature sensitive bridge. "Pulse" systems. "Rapid cycle" control. Temperature sensitive resistance elements. Amplifiers. Aircraft air valves. Valve actuators and mechanisms.

The use of on-off controls in aircraft temperature control systems is usually limited to primary and safety control applications as part of the controlled equipment. An example would be the fuel and limit controls for combustion heater which include fuel solenoids, ignition controls, overheat themal switches, and other controls basic to the heater itself. A variety of thermostats are in use for these applications include: the expanding shell, invar rod and expanding tube, and bimetal disc types.

Proportioning Type Controls.

Proportioning (modulating) controls are widely applied to the positioning of the various air valves in the air conditioning system. In those proportioning systems employing the conventional bridge a slidewire in the valve actuator feeds the signal back to balance the bridge. In several forms of modified bridge currently employed the actuator slidewire is replaced by two electrically-heated temperature sensitive resistance elements which are built into the amplifier assembly and electrically connected in opposite legs of the bridge.

Upon a deviation from the control point sufficient to unbalance the bridge, the amplifier simultaneously begins to reposition the actuator and to energize the heater winding of one of the so-called "pulse" elements. The heating of the temperature sensitive resistance provides the signal to rebalance the bridge, the duration of the "pulse" being a function of the extent of temperature deviation and the interval since the last temperature deviation in the same direction, i.e., toward "heat" or "cool." The two "pulse" elements work against each other, one responding to temperature deviation calling for an increase of heat supply, the other responding to temperature deviation calling for a decrease of heat supply.

The "rapid cycle" bridge is designed for the rapid cycling of combustion heaters to provide large amounts of heat in fairly short pulses. The unbalance of the bridge caused by temperature deviation at the control element is corrected by the resistance change of a duct element in the heater to re-balance the bridge. The rate of cycling is a function of the response time of the discharge element, bridge differential, as well as heater response and other factors.

Design of Sensing Elements.

These controls are based on different forms of the temperature sensitive Wheatstone bridge using wire-wound positive coefficient sensing elements or negative coefficient material such as thermistor. Either type is suitably mounted and protected for duct or cabin installation and provided with standard aircraft electrical connectors.

The protection of temperature sensitive resistance elements against environmental conditions and mechanical

damage imposes certain design problems. In addition to the goal of minimum weight basic to all aircraft design, it is desirable to keep the mass down so as to reduce lags in response, yet the element must have the mechanical strength to resist shock and vibration.

Although the resistance material should, for greatest sensitivity, have maximum exposure to the air, there must be protection against moisture, corrosion, and physical damage resulting from impingement of particles in the high velocity airstream. Moisture and particularly salt atmosphere not only can cause partial or complete short-circuit of the element but also will promote electrolytic corrosion. Protection, particularly of wire elements, without excessive decrease of sensitivity presents obvious difficulties to the temperature control manufacturer.

Both vacuum tube and polarized relay amplifiers are used as bridge detectors. Design of vacuum tube amplifiers follows conventional aircraft electronic practice with the same emphasis on ruggedized components. Polarized relay design has tended to follow the trend toward hermetic sealing which affords the same protection as the tube against environmental conditions at the sacrifice of accessibility to contacts and adjustments. This same penalty, however, has been imposed and accepted for the majority of relays used in aircraft applications.

Types of Air Valves Employed

A variety of basic types of air valves are used in aircraft temperature control applications. Most common is the butterfly valve which presents distinct advantages of light weight and simplicity. Unfortunately, the flow characteristics of the simple butterfly are like those of any single leaf round damper and make difficult linear control of flow in relation to actuator travel.

A variety of compromises have been tried in the design of the butterfly mechanism and linkage. Various expedients have been employed such as taper wound slidewire in the actuator to concentrate control movement within the effective range of the butterfly. In all cases where any type of air valve is used as a proportioning device, great care is used in selecting actuator speed to match system characteristics and avoid an oscillating or hunting condition.

In slide and gate valves, it is possible to shape the slide and gate mechanism for improved, more linear, flow characteristics, but these valves tend to be heavier and more complex than the butterfly and hence are less widely used in the control of air flow.

As valve operating temperatures and pressures increase, leakage and material problems increase. With temperatures of 700°F. and higher, and pressures of 150 psi or greater, of the air bled to the valve from the jet engine, the problems of an effective seal and suitable materials are greatly increased. Piston ring seals are used for many butterfly applications. In others the butterfly linkage is arranged to jam the butterfly against the carefully machined seat at the end of the closing stroke without the use of the ring device.

Slide and gate valves move the slide between seals or machined side plates past the valve ports, but again temperature and pressure create leakage and material problems. To reduce weight, space, and complexity it is desirable to couple the actuator as closely as possible to the valve or even incorporate the actuator mechanism in the valve casting. This creates the problem of protecting the actuator motor, gears, and limit switch mechanism from excessive temperature.

Valve Actuators

The bulk of actuators used in valve control are of the rotary rather than the linear type. Actuator travel is adjusted to the valve mechanism either by cam-operated limit switches (preselected or adjustable cams) or such devices as the Geneva lock, torque limit switch, or slip clutch are employed to make the actuator independent of mechanical limits of valve travel.

In valve applications requiring a high speed actuator it may be necessary to equip the actuator with a brake if there is a tendency for the actuator to coast beyond the valve position demanded by the control system. With a slower actuator the longer gear train tends to reduce coast to a negligible factor. Where a brake is fitted, it is usually an electro-mechanical brake using discs and a pull-in coil. If the valve is not used as an infrequently operated shut-off device but is required to reposition at fairly frequent intervals, it may be necessary to add a radio noise filter to the actuator.

Design Emphasis

Reliability, sensitivity, accuracy, weight and cost. Environmental conditions.

In the design of aircraft cabin temperature control systems and their components, emphasis is on reliability, sensitivity, accuracy, weight, and cost —usually in the order named. For the factors affecting reliability and performance there are comprehensive specifications issued by the military and supplemented by specifications issued by individual airframe manufacturers and airline operators, although these latter tend to apply to specific aircraft and applications.

Where the control equipment is provided to the manufacturer of the air conditioning or heating equipment for resale in a packaged installation, additional specifications may have to be met. Finally, there are standards and recommended practices which are established by committees of the engineering societies connected with the aviation industry.

There are several extremes of environmental conditions which the control system components must meet: temperature, pressure, humidity, vibration, sand and dust, salt spray, and fungus. In qualification tests there are combinations of these extremes; for example, fungus and humidity, low temperature and high altitude, etc. In addition to environmental tests, there are life tests which may be combined with one or more environmental tests.

Usually further tests are called out as checks on the electrical characteristics of the components where such tests are applicable. The severity of these test specifications in general are such as to explain the trend toward hermetically sealed or potted plug-in components for such portions of the control system as the amplifier.

This environmental protection is in most instances only achieved at the expense of making the component expendable since the majority of the units are unrepairable after being hermetically sealed in a metal can and particularly after being imbedded in a solid plastic block. Enclosing or embedding the component also increases the problem of dissipating the heat generated by electronic components and means great attention must be given to possible self-heating if satisfactory service life is to be obtained.

Trend

Toward and from complexity—Pneumatic controls—Combination systems.

Operational and service difficulties with the fully automatic cabin temperature control systems of immediate post-war aircraft brought about a decided trend toward a certain amount of manual control, particularly in the transfers between different portions of the heating, ventilating, and cooling cycles. Recently the trend again appears to be reversing toward the fully automatic system. This probably has a dual explanation, namely: (1) the increasing pressure of other duties on the flight personnel and (2) the increased reliability of the cabin temperature control equipment itself coupled with a better understanding in the aviation industry of the proper application of temperature controls.

Some interest has been shown lately in the possibilities of pneumatic control although largely confined to pneumatic actuation of valves. The temptation to utilize the available supply of hot, high pressure air is somewhat offset by the weight of mechanisms and piping to use air at those temperatures and pressures for control purposes. There remain, however, possibilities for a system which could utilize electronic temperature sensing and pneumatic actuation if combined to present weight and reliability advantages over existing all-electric cabin temperature control systems.

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that separates the dial from the Bourdon Tube and movement. Three ¾" lugs on the back flange hold the *Maxisafe* away from the wall and permit the safety plate to release. *The case design also provides easy, quick access to the movement and tube assembly for inspection, repair or recalibration.*

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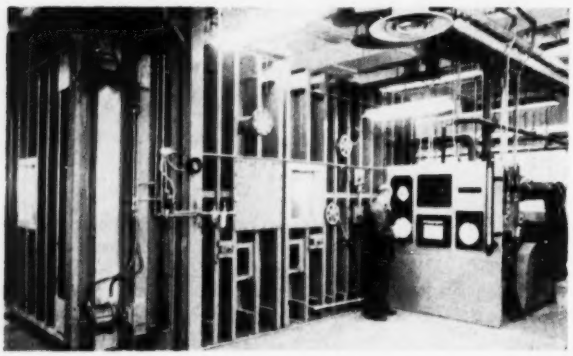
INSTRUMENTS ON THE MARCH

New Principles. Applications. Non-commercial Developments

Environmental Test Chamber

AKRON, OHIO—To test finished products, sub-assemblies, components and materials, the Goodyear Aircraft Corporation, Akron, Ohio recently installed a new, specially designed 440-cu.-ft. environmental test chamber. Designed and manufactured by Tenney Engineering, Inc., Newark, N. J., the chamber produces temperatures ranging from minus 100 to plus 200 deg. F.; humidity from 20 to 95 percent; and vacuum pressures from atmospheric to one



inch of mercury absolute (sea level to 75,000 feet). Vacuum can be brought from sea level to one-inch mercury in 20 min. Specifications call for dissipation of 3 kw. operating load at minus 100 deg. F.

In addition to the variable temperature, humidity, and altitude provisions (all may be varied independently of each other), the chamber is equipped with two 3000-rpm. power shafts and two terminal pads so that mechanical and electrical energy can be brought into the chamber for testing equipment under actual operating conditions.

Pipeline Control by Pressure Cells

INDEPENDENCE, KANSAS.—Baldwin-Lima-Hamilton Corporation, Philadelphia 42, Pa., announces that its SR-4 pressure cells and instrumentation have been selected by Sinclair Pipe Line Company for a new 674-mile, 22-inch crude oil pipeline being built between Drumright, Okla., and East Chicago.

These pressure cells were recently applied in oil-pumping station control for the first time in a pipeline across the southern states. The cells sense pressures directly in the line and do not require product lines to the control panel. Pressure variations are transmitted to a central instrument panel by 4-8 volt lines carrying less than 0.1 ampere and using less than one watt of energy.

The new Sinclair crude line will have telemetering communication between a central control and dispatching office in Independence, Kansas, and the 10 stations along the line. A microwave system will provide for remote pressure indications, flow alarms, and partial control of each station from Independence. The line will require nearly 70 pressure cells which will be in the suction and discharge of each pump and each station. Capacities of these cells range from 600 to 1200 lb. per sq. inch.

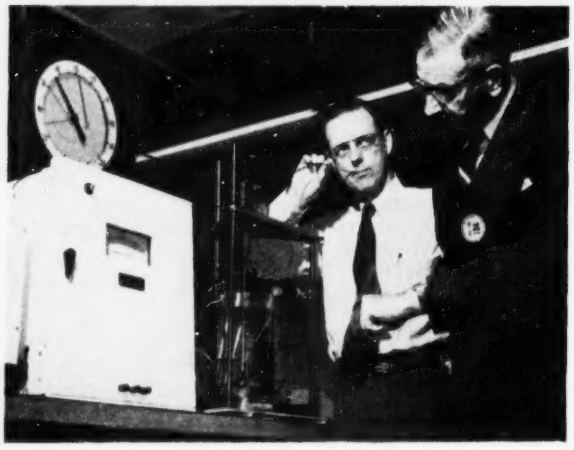
Transistors in Telephone Networks

ENGLEWOOD, N. J.—The transistor will go to work for the first time in the nation's telephone network in dial-switching equipment in Englewood, N. J., as a part of the customer long distance dialing service introduced by the Bell System there last year. Englewood customers are able to dial, direct, to reach telephones in such distant cities as Cleveland, Chicago and San Francisco.

Transistor oscillator units will be used in sending out electrical signals in the form of six musical tones of varying frequencies, combinations of which represent the digits of a telephone number. After being transmitted, the musical tones are converted back to ordinary electrical signals at the receiving central office.

Rapid Blood-donor Tests

PHILADELPHIA, PA.—To speed processing time of blood donors, engineers from Minneapolis-Honeywell's Industrial Division developed the "thermotron," an electronic instrument twice as accurate as a doctor's thermometer and 60 times as fast. Here R. A. Terry, M-H engineer, holds

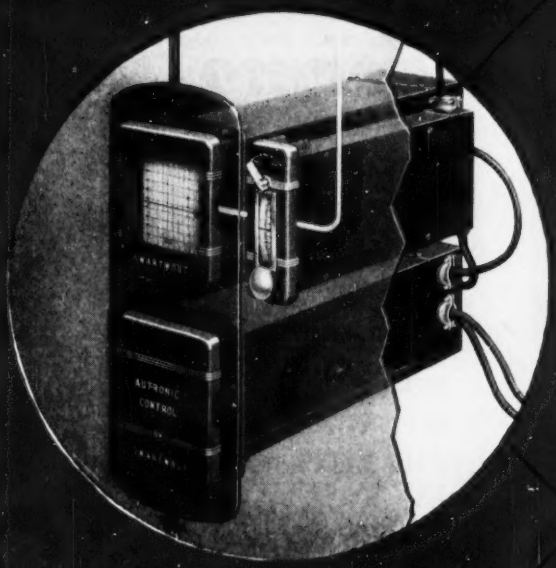


the instrument's temperature sensing element, a stainless steel thermocouple, in his mouth as Dr. W. T. Lineberry, medical director for the Red Cross' Philadelphia regional blood center, measures reaction time. It took less than 4½ seconds to register the temperature. Using conventional thermometers the time runs from two to five minutes.

Computers in Industry

KANSAS CITY, MO.—On January 8 and 9, nearly 200 top-flight representatives from industry, government, universities and research organizations from coast to coast and Canada attended a two-day meeting sponsored by Midwest Research Institute on industrial uses of automatic computing equipment. Cooperating societies were the American Society of Mechanical Engineers, American Society of Civil Engineers, American Institute of Chemical Engineers, Instrument Society of America, American Institute of Electrical Engineers, Institute of Radio Engineers, and the Society of Automotive Engineers.

Swartwout Autronic Control System



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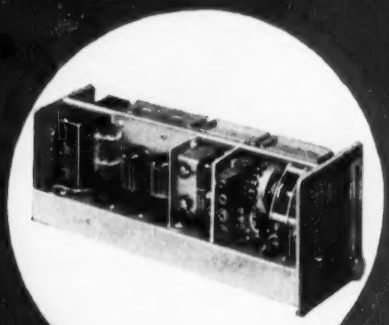

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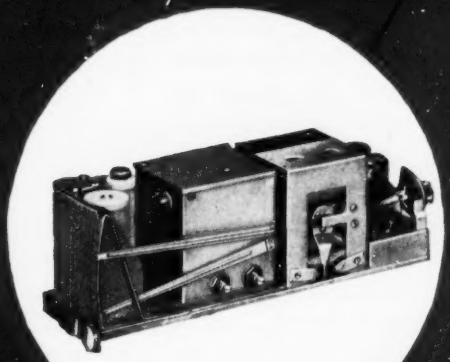

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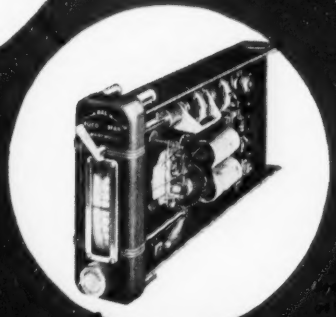

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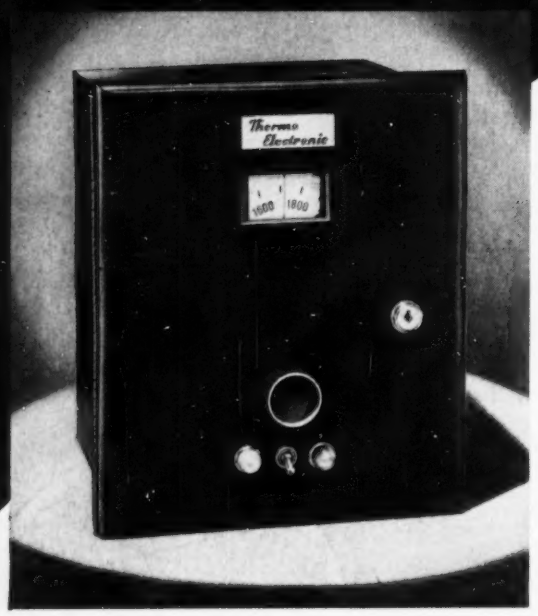

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25 Years of Progress

By T. K. M. SMITH
Pacific Lighting Gas Supply Co.

ALTHOUGH much already has been written and said about the founding of the Southern California Meter Association, I feel that it is appropriate to briefly relate its origin on this occasion, its 25th anniversary.

It was a quarter of a century ago, in the year 1927, during the month of July, that a group of men interested in fluid measurement and related subjects gave serious thought to the need for organizing a society whereby a permanent medium for exchange of ideas, experience, and knowledge might be put into use so that others of similar interests could be benefited, and the results passed on to companies represented through the membership.

As a preliminary step, a meeting was arranged during that month, at which time 12 men representing a like number of companies gathered in Anaheim, California, for the purpose of exploring the possibilities of such an organization. At this meeting, a plan was presented in which the aims were outlined.

Early Practices

The inception of the Southern California Meter Association might have been brought about by the fact that in those early days relatively few accepted standards were in effect so far as fluid measurement practices were concerned—other than those which were "basic." Some of our early methods in arriving at the actual flowing conditions of the gas were a far cry from the advancements of the present. For example, specific gravities were determined by the Shillings' bottle, and the results obtained depended somewhat upon the prevailing weather conditions at the time the testing was done. As to temperatures of the flowing gas, they were often guessed at by what some of us termed the "skin method." This technique consisted of feeling the pipe line with the hands and then, by agreement, deciding on what the temperature was thought to be. You can see that this procedure could become quite involved, especially if it had to do with a purchase or sale of a meter and whose hands felt the pipe.

Regarding orifice meter flow records, they were recorded on charts whose graduations were in pounds per square inch gauge, and inches of water differential. Tables of so called "Pressure Extensions" were used in calculating the volumes, a pressure extension being simply the product of the square root of the absolute pressure times the differential. Tables were available from the gauge manufacturer; all that I ever used were based on 14.4 pounds per square inch as a barometric pressure. This value was generally accepted unless otherwise stipulated by contract —then an "adjustment factor" was applied in the calculations.

In the early days we applied a correction for deviation from Boyle's law, but each particular source of gas had its own set of factors. Displacement tests requiring considerable time and painstaking effort were made, and the results were plotted from the actual data—quite a departure from today's procedure whereby knowledge of the pressure, temperatures, specific gravity, and the percentage of two chemical constituents is all that is required to be known. Today we call it the super-expansibility factor, otherwise known in the nomenclature terminology as F_{pv}.

Beveled-edge orifice plates were in universal use, made of mild steel, the scrutiny of which at times did not appear too important, and the exactitude of the pipe diameter, pressure taps, etc., seemed to be a minor consideration. Pressure regulators were mainly of the weight and lever type with quick opening valves, and not too much regard was given as to their proximity with respect to the orifice disk. Straightening vanes were uncommon, and those that were in use were of no standard design. In view of all these properties, surprising enough to say, our "unaccounted for" wasn't too far out of line.

Membership and Growth

Getting back to the early activities of the association, immediately following that preliminary session, several temporary committees were selected and preparations were soon underway for our "first" meeting, which was held two weeks later at the Elks Club in Anaheim. The response was gratifying; 57 interested (and perhaps curious) men attended, representing 15 companies. The purposes and aims were explained; and before the conclusion of the meeting a president, vice president, secretary, and treasurer had been elected. Various committees were appointed; one of the first orders of business was to draw up a code of by-laws which, except for a few minor changes, is still in use today.

Western Gas, a monthly Los Angeles publication that realized the objective and the need, became interested in the association from the start and rendered a helpful and valuable service in representing the association as its first official publication, which they continued to do for several years.

By the end of the fiscal year, the membership consisted of 124 active members, representing 26 companies, and eight associated members—a total of 132. While on the subject of membership, I would like to quote some

March Meeting: Thursday, the 19, Rio Hondo Country Club, Downey, Calif.

Feature: Mr. Glen Brockett, of the Fisher Governor Company, will present a paper on "Selection of Control Valves".

interesting figures and facts that our secretary has furnished. As of tonight, we have a total of 510 members. Of this number 372 are active members, 85 are associated members, and 53 are sustaining members.

During the past nine years (the only comparative figures I have) the membership has shown a remarkable increase in all classifications, which is indicative of the splendid work the officers and committees have been doing. Here is a record to be proud of. Today, out of the original 132 members of 25 years ago, 38 have retained their membership—and of this 38, eight have served as presidents.

There have been 26 past presidents, and of this number 24 still are on the membership roll. One of the 26 was removed by death, a loss which has always been keenly felt by the Association and throughout the industry. The other past president resigned to engage in private business. Of the 24, two are Honorary Past Presidents.

Meetings

For years we had no permanent meeting place; locations were usually chosen for the convenience of the members. Golf tournaments attracted numerous foursomes, and through the generosity of some of the companies and business houses there were always valuable prizes for the winners—I wonder what has become of the "S.C.M.A.—Western Gas Good Fellowship" trophy.

Now about "High Jinks." These annual affairs speak for themselves, and I shall not go into any detail except to say that in the early days it seemed advantageous to change the locale each year. I remember two extremes—from a swanky country club in Beverly Hills to the Central Manufacturing District Club in the Los Angeles stock yards.

By contrast, we went high-brow on one occasion and added a little flavor of culture to our meetings. We sponsored and presented the G. Allen Hancock string ensemble and, in conjunction with a rare musical treat, we viewed a motion picture narrating the story of a scientific exploration of the Galapogos Islands and other rarely visited shores of the equatorial Pacific. The affair was held in Los Angeles, also in the auditorium of the Los Angeles Gas and Electric building. Our families and friends were guests.

Several well-arranged conducted tours through some of the large industrial plants were part of the association's activities and were always well attended.

Projects

Now let us touch on some of the outstanding projects undertaken and sponsored by the Association, but not in order of importance.

Meter Man's Handbook

Within a couple of years after organizing it was realized that there was a need for a reference book with information helpful to those engaged in measuring fluids, etc. Upon consideration of the matter, the Standards Committee assembled various available data. Put in loose-leaf form, this has become the *Meter Man's Handbook*. Starting out with but a few pages of essential material, it has grown in size so that it now contains 16 sections with more than 200 separate data sheets, suitably indexed. The Association has kept pace with the advancements, improvements, and progress made throughout the years by keeping this handbook up-to-date. So great has the demand been for this collection of tables, alignment charts, formulae, etc., that hundreds of the handbooks have been sold, some beyond the continental limits of the United States.

Gadget Club

Back in 1929 a fictitious club known as the "Gadget Club" was formed. Its purpose was to encourage the introduction of new and useful ideas submitted by the members. The gadgets submitted were reviewed by a special committee of five members and were judged by a series of point scoring. The prizes which were awarded consisted of $10 for first prize, a Natural Gas handbook by Diehl as second prize, and a leather-covered LeFax Handbook as third prize. As I recall there were other prizes for runner-ups. Considerable interest was taken in the club, and novel and ingenious ideas were presented.

Extension Correspondence Course

Perhaps one of the most interesting projects undertaken was the "Extension Correspondence Course on the Measurement of Gas." This project was under the direct supervision of an Educational Department of the Association, comprising a chairman and 15 active members. The course was extensive, consisting of 20 separate lessons with problems and lectures. The services of a Mr. L. L. Sutherland, who was a member of the faculty of the Huntington Park High School were obtained, and a comprehensive agreement between the educator and the association was made. Professor Sutherland had a background of valuable experience in off-the-job educational courses, especially in matters relating to the subject of fluid measurement.

Upon completion of the course, an apropriate certificate was issued to the student. The price for the entire course was $17 to members, and $18 to non-members. Of these amounts the association received $1 and $2 respectively. To illustrate how popular this course was, it was first available during the month of March; by October of the same year the number that subscribed to it had reached the surprising total of 137, which included students from 13 states and two foreign countries. At the expiration of the course, 150 students had been benefited; the association had filled a need and again had proved itself a definite asset to its members and to the industry in general.

Expositions

Expositions were held at which equipment relating to the gas industry were on display. The first one was in 1931, in the auditorium of the then Los Angeles Gas and Electric Building in Los Angeles. The idea proved to be popular and other expositions followed.

In 1948 a splendid job was done in staging the exposition in the Long Beach Municipal Auditorium. It was a big undertaking that required advanced planning, hard work, and enthusiasm.

Our prominence was acknowledged by the fact that on several occasions we acted jointly with other associations in establishing certain standards in gas-measurement procedure.

Instrument Maintenance Short Course

Perhaps one of the outstanding and most satisfying projects undertaken by the Association is the three-day "Instrument Maintenance Short Course" in conjunction with the Los Angeles Harbor Junior College at Wilmington, California. Regarding the one held in 1952, it was truly amazing at the interest manifested in the scheduled programs along with the exhibits of various equipment. The scope of the classes and lectures embraced numerous subjects allied to the oil and gas industry. The locale was well chosen, being within the shadow of a great oil refinery and within sight of numerous oil derricks. I am told that the registration exceeded 450, which surpassed the previous one.

Conclusion

I have endeavored to give you a brief account of some of the past happenings. The high standard of service rendered needs no elaboration. Had it not been for the men who have so unselfishly given of their time in the administration of their various duties, the success and recognition attained by the association would not have been possible. To pay credit where credit is due would be difficult. I have neither time nor space to express adequate praise for the numerous worthwhile and outstanding accomplishments of any individual, committee, or group.

Our representation through affiliation with *Instruments* magazine as the Journal of the Southern California Meter Association is evidence in itself of the important position we occupy in the industry.

In closing, I possess a sense of great satisfaction in knowing of the progress made during these past 25 years, and I appreciate the small part that was allotted to me during the association's early life. I value most highly, as the result of my membership of long standing, the privilege and good fortune that I have had in making so many sincere friends.

If it were possible to turn back the hands of time and to start anew, I doubt very much if a better job could have been done by those who had the interest of the association at heart.

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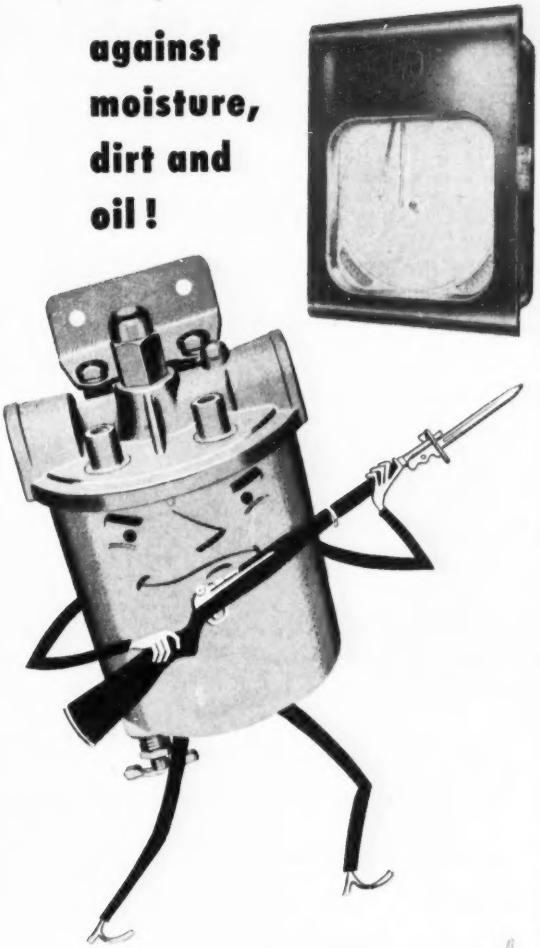

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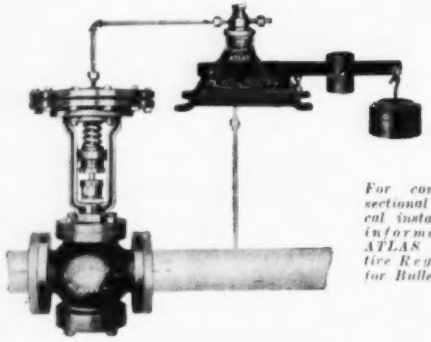

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OXYGEN RECORDERS

Continued from page 251

of the quartz fiber. A beam of light, reflected from the mirror, is deflected in accordance with the rotation of the test body and indicates oxygen concentration by the position of a spot of light on a calibrated translucent scale.

In the Beckman null-balance recorder (Fig. 8), the test body is restored to its null position by the application of an electrostatic force equal and opposed to the magnetic force produced by the gas sample. The glass test body is metal coated to make it conductive and is connected to a variable source of electrical potential. Near the test body are two electrodes maintained at fixed electrical potentials and arranged to constitute, with the test body, a heterostatic electrometer. The potential required to hold the test body in null position is a direct measure of the oxygen concentration of the gases surrounding the test body. The beam of light reflected from the mirror attached to the test body is divided between two photocells. Any motion of the test body due to change in oxygen concentrations results in an unbalance in the light on the photocells. This unbalance produces an electrical current which is amplified by the photocell amplifier and the balancing motor amplifier, and used to drive a balancing motor. The motor is coupled to a potentiometer which supplies a variable potential to the test body. Any change in magnetic force due to a change in oxygen partial pressure is always balanced by an electrostatic force which in turn is proportional to the direct-current voltage delivered to the potentiometer. Thus, changes in oxygen partial pressure are accurately translated into proportional voltage changes which can be recorded on commercial recording potentiometers. The oxygen analyzer is thermostatically controlled to eliminate variable temperature effects and the instrument is shock-mounted to protect the test-body suspension from shock or vibration. The components exposed to the sample can be made corrosion resistant when necessary.

Hays "Magnotherm" Cell Block

Fig. 9 shows the cell-block assembly for the Hays oxygen recorder, which utilizes this same magnetic principle. However, the manner in which the principle is applied is different. The two cells each contain a platinum spiral resistor completely enclosed in glass. The two spiral resistors form two legs of a resistance bridge. They are energized from the bridge supply of 12 volts and are heated to a temperature of approximately 450 deg. F. Under normal conditions, with the same gas sample in each cell and no disturbance of any kind taking place, the bridge will remain balanced regardless of the gas composition in the two cells. The gas coming into the instrument flows across the bottom of the two cells and out to atmosphere.

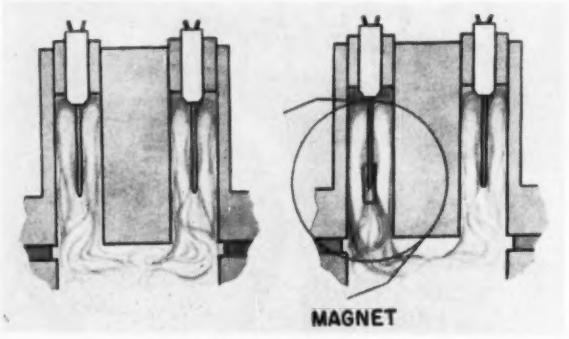

Fig. 9. Hays "Magnotherm" cell.

The gas sample diffuses up into the two cell compartments. There is no flow through the cell and only normal convection currents exist within the cells themselves. The left-hand illustration shows a cell assembly with gas containing oxygen in both compartments; the bridge is balanced regardless of the gas composition.

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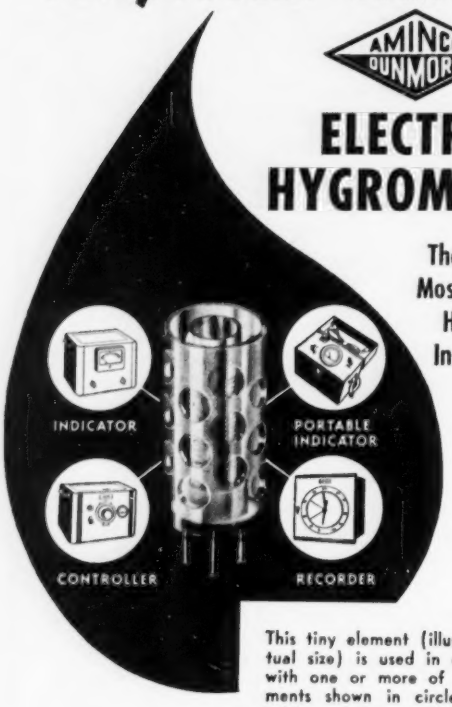

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The right-hand view shows what occurs when we add a magnetic field to the left-hand cell. A strong magnetic field is produced by pole pieces immediately opposite the end of the heated resistor. This strong magnetic field attracts the cool oxygen-bearing gas near the bottom of the cell and draws it up into the magnetic field. As it is drawn into the magnetic field the oxygen-bearing gas is heated by the resistor, and as the gas is heated it becomes less magnetic. The cooler gas, being more magnetic and being pulled in from the bottom, pushes the warmer gas up out of the magnetic field and a forced circulation is set up in the cell. The circulation of the gas in this cell cools the spiral and, therefore, reduces its electrical resistance. The spiral in the right-hand cell is affected only by the normal convection current. Therefore, there is a much greater cooling effect and a much greater change in resistance in the left-hand cell. The resistance change is measured by a bridge-balancing recorder, and the instrument is calibrated in percent oxygen.

Fig. 10 shows the complete oxygen analyzing and recording mechanism. The two measuring chambers contain the two spirals that form two legs of a bridge. Two fixed resistors complete the bridge circuit. A high-gain amplifier detects the unbalance produced by a change in oxygen content, amplifies the unbalance, and applies the resultant voltage to one coil of a two-phase motor driving the pen. The pen-drive motor also operates the balancing potentiometer

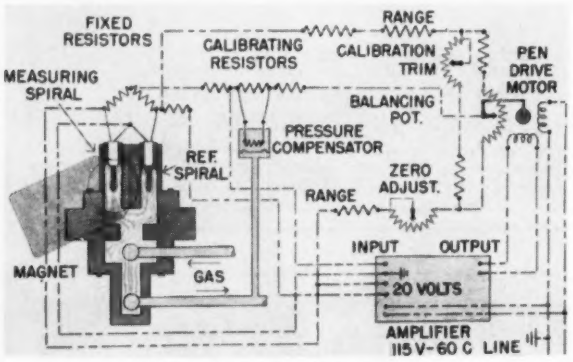

Fig. 10. Hays O_2 analyzer-recorder.

to rebalance the electrical circuit. A cam in the recorder provides a linear relationship between percent oxygen recorded and bridge unbalance.

Potentiometers are provided for zero and calibration adjustment. Other fixed resistors for determining the range and final instrument calibration and for reducing the bridge voltage are contained in a calibrating box mounted in the recorder. A pressure compensator is used also. Oxygen recorders using the paramagnetic principle measure the partial pressure of oxygen. Any variation in the sample pressure would make it impossible to calibrate the instrument in percent oxygen. Thus the pressure compensator is used to correct the calibration for variations in the absolute pressure of the gas sample. The compensator measures the pressure of the gas leaving the instrument and changes the resistance in the calibration circuit. Thus the instrument can be calibrated in percent oxygen, even though sample pressure may vary somewhat. As the paramagnetic properties vary with temperature, it is necessary also to operate at a constant base temperature. The analyzing section is housed in an insulated cabinet equipped with a heater and thermostat.

Sampling System

The proper operation of any gas analyzer depends to a great extent upon the sampling system. Fig. 11 shows a sampling system for obtaining a sample from the flue of the catalyst regenerator on a fluid catalytic cracking unit. Normally the sample is taken near the outlet of the regenerator before the sample enters the precipitator or final separating unit. If there is a slide valve in the system, as

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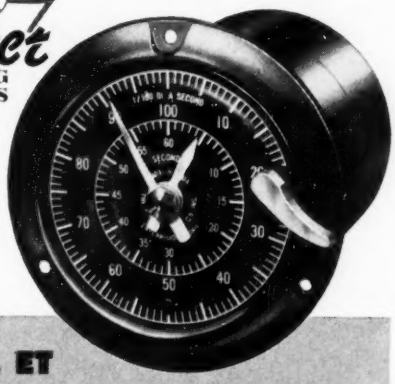

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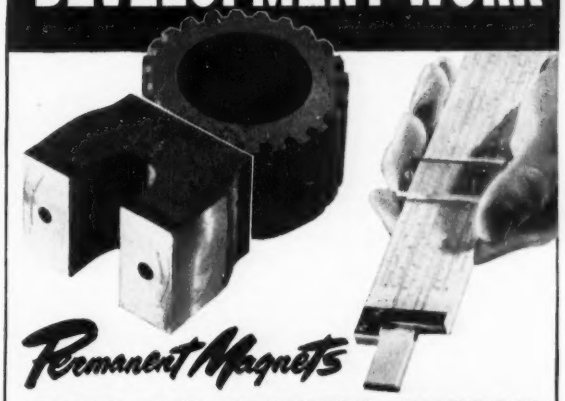

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shown, or if it is possible to exhaust the sample into a low-pressure portion of the system, a recirculating system is used. Approximately 5-psi. drop is required across the cyclone filter. On some types of cracking units it is possible to obtain this drop and to pipe the exhaust back into the system. On other units it is necessary to exhaust the sample to atmosphere. However, the amount of catalyst lost in this way is not too great.

The gas sample is passed through the cyclone filter at relatively high velocities. The cyclone and filter assembly contains a perforated shell equipped with vanes which spin the gas passing through the chamber. Particles of catalysts are thrown to the outside of the chamber, leaving fairly clean gas near the center. The center section is equipped with a refractory filter through which a portion of the total sample is forced. The amount of sample drawn through this center filter is controlled by the sample flow control

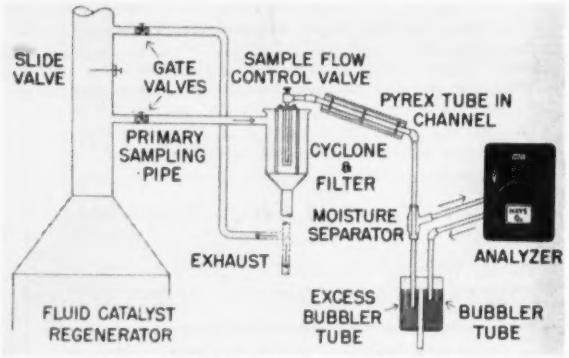

Fig. 11. Catalyst regenerator sampling system.

valve at the top of the assembly. The sample then is piped through glass tubing and rubber connectors to a moisture-separating Y. Condensate drains down into the bubbler. The gas, however, reverses direction and passes through the analyzer and then down to the bubbler. Note that the tubes in the bubbler are of slightly different lengths. This maintains a differential pressure of approximately ½-inch water column across the analyzer. However, the analyzer is not flow sensitive and it is not necessary to have a measured quantity of gas flowing through the analyzer. Therefore, accurate control of the flow through the analyzer is not essential. The half-inch differential merely holds the flow within reasonable limits. This arrangement provides a sample free from catalysts and moisture and also with minimum delay

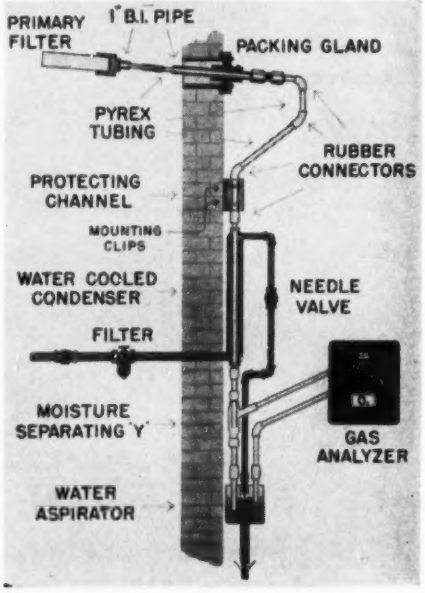

Fig. 12. Filter-aspirator sampling system.

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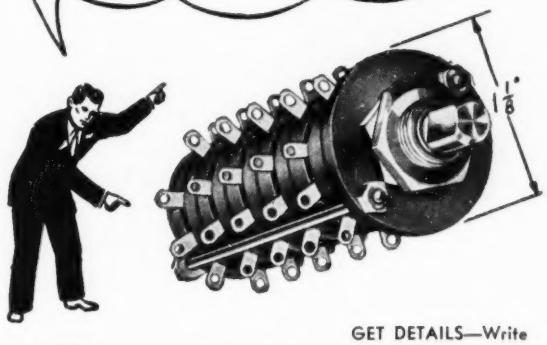

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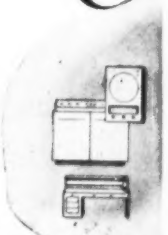

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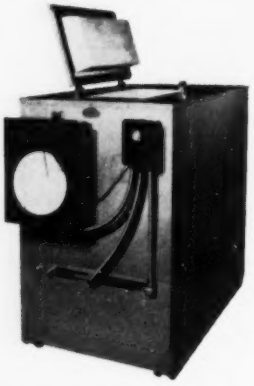

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because of the relatively high flow through the main sampling lines and the cyclone and filter assembly.

Fig. 12 shows a filter-aspirator gas-sampling system commonly used on boilers and heaters. Note that a primary filter of the refractory type is used and that the filter is supported on a 1-inch black iron pipe. A glass tube extends through the black iron pipe to the filter. The sample is carried in glass from the filter to the analyzer. A packing gland is provided on the end of the 1-inch pipe to seal the system against air infiltration. Glass tubing and rubber connectors then are used to carry the sample to the instrument and aspirator. The tubing is mounted in a protecting channel by special mounting clips.

Note also that a water-cooled condenser is used to condense out any moisture or sulphuric acid that might be in the system. The condensate drains down through the moisture-separating Y into the water aspirator. At the moisure-separating Y, the gas sample reverses direction and flows through the analyzer and then back down to the water aspirator; the two tubes in the water aspirator are of slightly different lengths to obtain a differential of approximately ½-inch of water across the gas analyzer. A small scoop tube is provided near the bottom of the analyzer so that a portion of the water is forced into the aspirator chamber, providing a continuous purging action. Any surplus water overflows through the opening through which the gas passes and drains out.

Fig. 13 shows a recently developed gas-sampling system which is being used successfully on pulverized-coal installations and jobs where the dust loading is high. A water aspirator draws the sample from the setting; a primary filter is not used. An open pipe brings the sample from the setting to the instrument. A water-cooled condenser is used to drop out water or sulphuric acid, as in the other systems. The same water then flows through the aspirator, through an overflow chamber, and out to drain. The gas sample is drawn through the condenser, through a secondary filter, through a motor-operated valve, through a moisture-separating Y, to the analyzer, and back to the aspirator. This is the procedure under normal operating conditions.

The system is equipped with a timer, a motor-operated valve, and a solenoid air valve. The water from the aspirator flows into an overflow chamber and from there through a check valve into a series of U tubes at the bottom of the assembly. The water in these tubes serves as a seal on the gas sample. The water is maintained at the height of the overflow while a gas sample is being drawn and the instrument is operating.

The timer is adjustable and can be set for any desired frequency of operation. When the timer operates, the motor-operated diaphragm valve is closed, shutting off the gas supply to the analyzer and to the aspirator. This isolates the analyzer from the rest of the sampling system. When

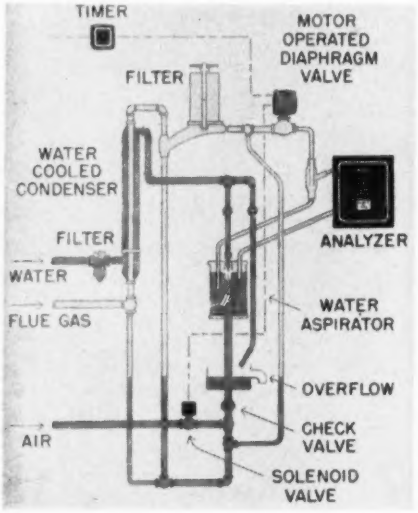

Fig. 13. Hays shot-clean sampling system.

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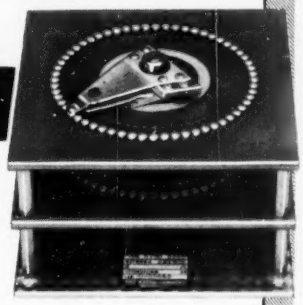

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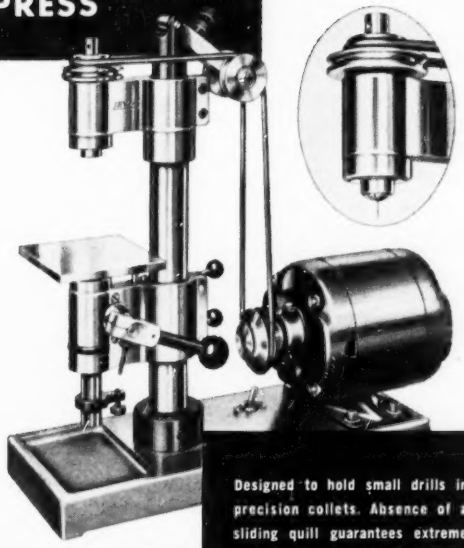

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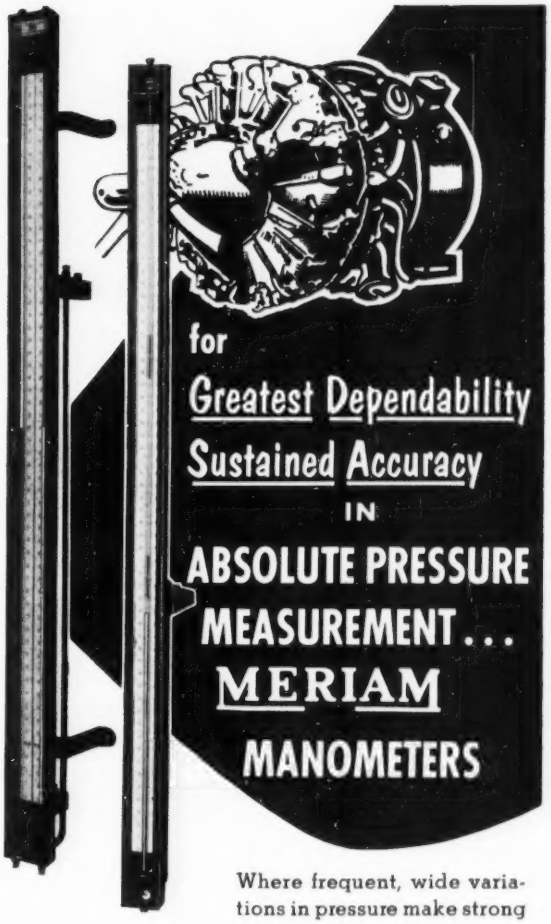

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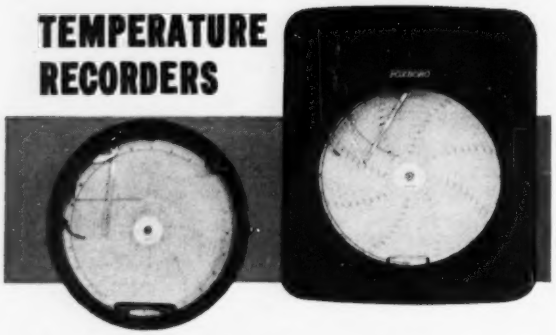

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the diaphragm valve reaches the closed position, a contact is made which energizes the solenoid valve in the air line. Air at pressure up to 100 lbs. is then applied to the bottom of the system. The check valve immediately closes, making it impossible to blow air up through the reservoir and overflow. Air pressure is then applied on the other three legs containing water. The main charge of water goes up through the pipe to the gas-sampling connection and then down through the water-cooled condenser and on out through the flue gas connection. An auxiliary charge of water with air behind it goes directly to the flue gas pipe and flows out through it. There is also a small auxiliary flow up through the filter assembly and back into the gas system. With this arrangement we have a finely divided water spray with high-pressure air behind it for scrubbing and purging the gas connection. With this system it is possible to use an open pipe for gas sampling, and the pipe can be kept clean for extended periods. Where high gas temperatures exist, it is sometimes necessary to use a water-cooled sampling pipe. However, the system can be piped so that the same water can be used for cooling the sampling pipe. The moisture-separating Y and the differential bubbler provide the proper sample at the analyzer.

The successful operation of any gas-analyzer instrument depends upon obtaining a clean gas sample with minimum delay. All manufacturers are aware of the importance of this problem and are constantly working to perfect the technique of gas sampling.

OPEN-HEARTH

Continued from page 258

The thermocouple assembly has an over-all length of about 9 feet and weighs approximately 27 lbs. Substituting 1.5-inch standard pipe for the 2-inch-O.D. tubing would raise this weight to 31 lbs., which is still a fairly light, serviceable thermocouple. Maintenance on this unit has been low as compared with the refractory-type couple. The parts are easily and quickly removed for replacement; except for the thermocouple assembly proper, including insulators, solder, and precious metals, the outer thermocouple assembly can be assembled completely in about five minutes, all integral parts being premachined and prefabricated. The cost of fabricating the unit, including 100 double inches of platinum wire, is about $150.00.

Maintenance between readings consists of knocking off the slag coating on the carbon sleeves, removing the plug and quartz tip assembly, and replacing it with a new one.

The plug and tip assembly is sent to the shop where, in batches of 40 to 50, the old quartz tip is removed, a new one inserted, and cement is applied to both ends of the plug. Other than replacement of the tip between readings, 90 percent of the maintenance is caused by mechanical damage due to improper handling; operators break carbon sleeves by dropping the thermocouple, tear off the polarized plug on the end of the extension lead-wire, etc. An insidious type of damage due to improper handling is broken insulators on the thermocouple. Such breaks can cut the thermocouple wire or cause it to twist, resulting in a secondary hot junction and a low reading. A secondary hot junction, by the way, cannot be located or detected by an ordinary continuity check. A so-called "hot-check" is necessary to locate such a defect.

The upper part of Fig. 8 shows the component parts of the thermocouple disassembled; the bottom part shows the assembled thermocouple.

Operation Factors

Fig. 9 shows two plugs, both of which had been used just once. One plug had a normal immersion. The other looked the way it did because the reading had been taken adjacent to an oxygen lance used for carbon reduction in the bath. The lance did a good job of carbon reduction on the thermocouple also; the reading was high and unreliable. This is one example of malpractice in use. The plugs in Fig. 9 are unusual in that they are moulded of graphite and carbon powders, pressed into a given shape under extremely high pressure and then fired at high temperatures. We are in-

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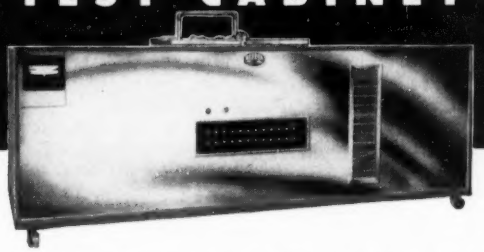

★ The Webber Low Temperature Test Cabinet illustrated is a standard 9 cubic foot unit with terminal panel added for electrical connection to the inner chamber for testing of electrical equipment. The temperature range is from ambient to −125°F., with a very rapid pull-down time. Temperature can be accurately controlled at any point in the temperature range. Temperature is controlled by a visible type indicating controller with a scale range from −200° to +200°F. Recording temperature controller is available as optional equipment. The freezing chamber will withstand impact loading of 1200 pounds per square foot and uniform distribution static loading of 2,000 pounds per square foot. This prevents damage caused by dropping heavy objects in storage compartment. Available as optional equipment are combination air and water cooled compressors and roller-bearing swivel type casters. There's a Webber Unit for every industrial need.

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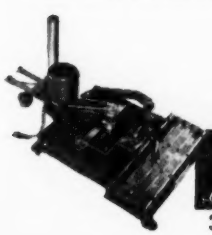

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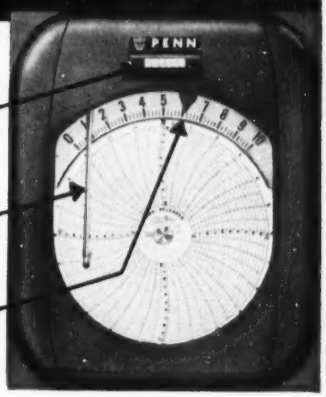

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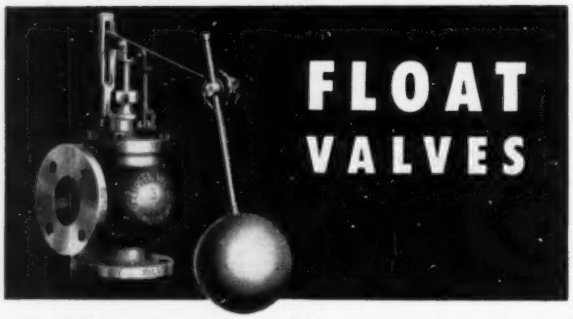

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vestigating their use because their cost is less than that of a tip machined from a carbon rod. To date, results have not been conclusive.

Fig. 10 shows the recorder for the equipment now in use in our new No. 4 Open Hearth Shop. The instrument board is shown in Fig. 1; the arrow points to the signal lights and bell which guide the first helper in his operation of the equipment. From left to right, the lights are green, amber, and red. As soon as the thermocouple is plugged in, the green light goes on, indicating continuity in the thermocouple circuit. This light should remain on during the entire immersion. The middle, or amber light, is lighted only when the pen is driving up scale, indicating to the operator that his temperature is rising and the instrument is responding properly. As the temperature approaches the final temperature asymptotically, the red light and bell (wired in parallel) operate when the slope on the curve reaches a certain preset minimum value, telling the first helper that it is time to remove the thermocouple. This method of using the slope to determine the temperature end point has many advantages and compensates for different thermocouple responses and lags. The bell is an audible alarm for the operator in event he can not turn around and watch for the red light.

An extension lead-wire box is shown in Fig. 2. This box is located to the right of the last door and serves as a retainer for the rubber-covered extension lead-wire. The lead wire is joined to the asbestos-covered lead wire, which comes from the conduit, in a small terminal strip in this box. This strip permits rapid replacement of the entire length of rubber-covered extension lead-wire in event it is severed by a charging machine. The extension lead-wires are long enough so that one furnace can use the recorder of an adjacent furnace in event of pyrometer outage.

Fig. 11 shows a typical chart record. The three phases of a reading—the abrupt initial temperature rise, the gradual slowing as final temperature is approached, and the familiar slag kick—are clearly visible. The short vertical trace at 2450 deg. is a record of the instrument standardizing itself. The standardization is automatic and occurs every reading.

In order to continually improve the operation of this equipment, a grading system has been in effect at both our Pittsburgh and Aliquippa works for some time. This grading system not only permits an analysis of operating performance, but also tends to allocate responsibility for malpractices. Every morning, each heat tapped the previous day is analyzed for bath temperature measurement performance and so graded. If the last reading on a heat is taken fifteen minutes before tap or spike, it is classed as "too early." Readings taken during the fifteen-minute period prior to tap or spike are classified as either "OK" or "Unreliable" depending on the correlation between temperature reading and pit performance of the heat. The table shows our bath temperature performance record for the first two months of this year. Note the number of readings. We now are taking readings at the rate of 500 per week. When our new open-hearth facilities are in full production it is anticipated that we will average 700 readings per week. Therefore, our problem in the immediate future is to further improve thermocouple design and operating technique to produce lower maintenance cost per reading.

JAN.-FEB. 1952
OPEN HEARTH BATH TEMP. READING PERFORMANCE

	Readings	
Category	*No.*	*%*
OK	1272	76.2
Too Early	330	19.8
Unable to Obtain (Operating Condition)	17	1.0
No Attempt	7	.4
Equipment out of Service—S.E. & C. Dept.	23	1.4
Equipment out of Service—Open Hearth Dept.	2	.1
Unreliable—S.E. & C. Dept.	17	1.0
Unreliable—Other	1	.1
Total	1669	100.0

Gross Number of Readings—3698
Readings per Heat— 2.22

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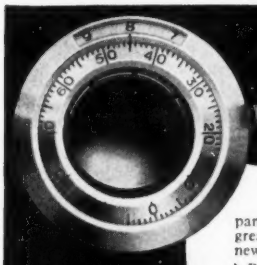

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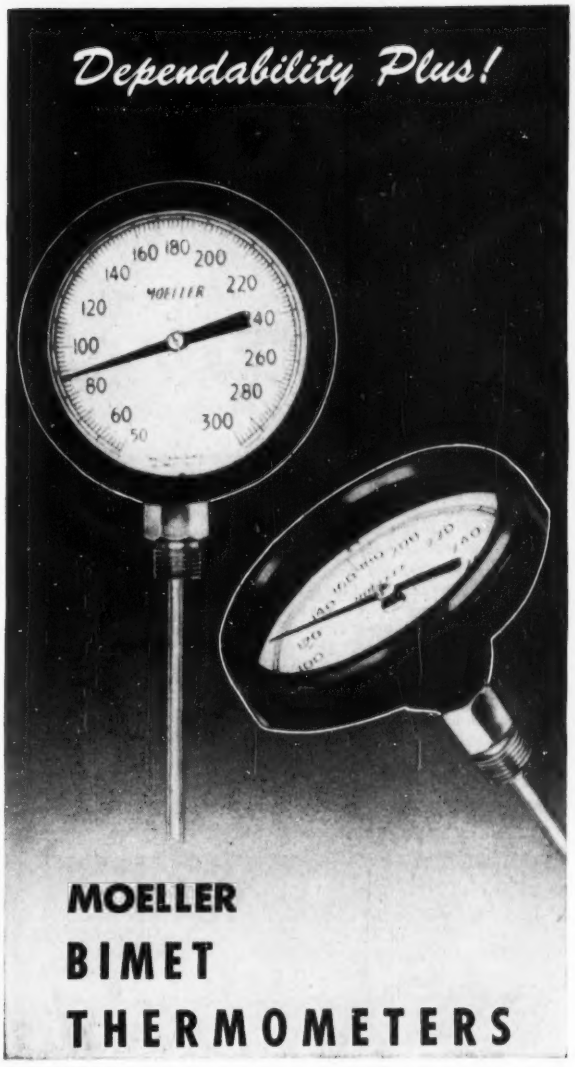

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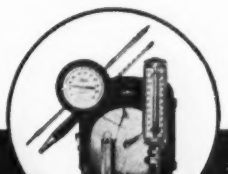

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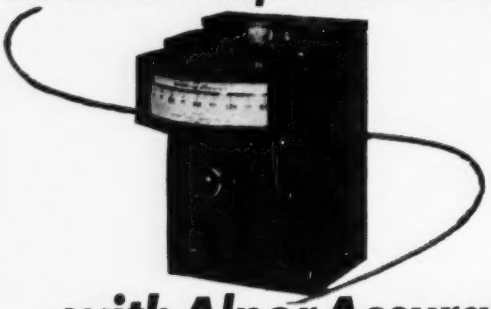

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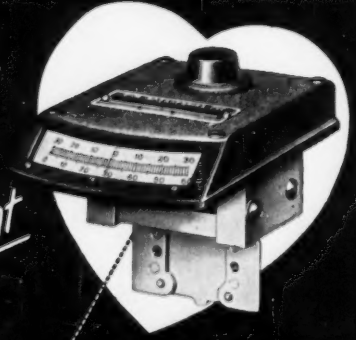

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CHEMICAL PROCESSES

Continued from page 255

detecting element. This may be several minutes after the change has commenced. (2) The shape of the curve at the beginning of the disturbance gives no information to the controlling unit on the magnitude of the change or rate of change of the process controlled condition. A human operator can rely on experience to know how much corrective action to take—and he may be wrong. The automatic controller can only wait for more information. It is clear that it is essential to reduce measuring lags to a minimum if best control is required. These conditions also emphasize the importance of the product (sensitivity × speed of response) for the measuring element.

In the expression for time lag, the thermal capacities and resistances of the metal parts are known. This is not true for (a) the air gap (or filling liquid) between the well wall and element, (b) the dirt film on the outside of the wall, and (c) the boundary layer between the wall and the surrounding fluid.

Experience based on experiment, or tabulated information compiled by someone else who has done experiments in similar conditions, is the only safe way to estimate (a) and (b). Item (c) becomes very small if the speed of the liquid past the well is kept high, above (say) 1 ft. per second. For gas the speed over the well should be 10 ft. per second or more. It is important to *either arrange for a close fit between bulb and well* or *fill the space with a good conductor* (oil or mercury). Also, keep the well surface clean, and decrease the liquid/wall boundary resistance to a minimum by keeping the fluid speed past the bulb high.

For the bulb shown in Fig. 2-4 let us consider what happens per unit length of the bulb. Oil is used as a conducting medium between wall and bulb.

The bulb itself and the mild-steel well can be considered as primarily thermal capacities (C_E and C_P); the liquid/pocket boundary and the filling oil primarily as thermal resistances (R_F *and* R_f). Then, per unit length, and in c.g.s. units:

$$C_E = \text{mass/unit length} \times \text{sp. heat} = 1.3$$
$$C_P = \text{mass/unit length} \times \text{sp. heat} = 2.48$$
$$R_F = 0.67 \text{ (by experiment, for a liquid speed of 100 ft./minute)}$$
$$R_f = \text{thickness of oil gap}/(\pi) \text{ (mean dia. of gap)} \times \text{(oil conductivity)}$$
$$R_f = 125$$

Substituting these values in the equation for L:

$$L = 1.3 \times 125 + (1.3 + 2.48)\ 0.67 = 165 \text{ sec.}$$

Note that R_f is the outstandingly high factor contributing to L. There is little point in reducing any of the others until the resistance of the oil layer is decreased. This can be done by fitting a new well to give a clearance of 0.01 instead of 0.08 inch between well and bulb. This brings R_f down to say 15. We then have:

$$L = 1.3 \times 15 + 3.78 \times 0.67 = 22 \text{ sec.}$$

instead of 165 sec.

If unavoidable lag is brought about by an anti-corrosion lead covering on the well, it would be necessary to reduce $(C_E + C_P)$. As the element capacity has been made small by the makers, the only possibility would be to reduce the capacity of the well, if a lighter construction would be safe.

Summary of Factors Making for Quick Response

When quick response of a thermometer element is essential (and it is always desirable) the following should be aimed at: (1) A close fitting bulb and well. (2) An oil filling (or mercury when conditions permit) in the gap. (3) A high speed (100-ft. per min.) of liquid over the well to keep a clean external surface of the well and to reduce the fluid/surface resistance to a minimum. (For gases the speed should be 500-ft. per min.). (4) The lightest-weight well compatible with plant conditions. (5) The deepest possible immersion of well, especially in small pipelines. If these factors are attended to, the manufacturers can be relied on to supply a sufficiently low-lag element.

Appendix to Chapter II on next page

APPENDIX TO CHAPTER II

Let us then consider the response of an element of long cylindrical shape (like a mercury in steel element) as shown in Fig. 2. The rate at which its temperature (θ_E) rises, when the surrounding fluid is at temperature θ_F, depends on the amount of heat ΔQ which flows into unit length of the element in a small time ΔT. The temperature change ($\Delta\theta_E$) of the element in this time interval will be given by :—

$$\Delta\theta_E = \frac{\Delta Q}{C_E}$$

where C_E = thermal capacity of the element/unit length.

$$\text{Now } \Delta Q = \frac{\theta_F - \theta_E}{R_F}\ \Delta T$$

where R_F = resistance to heat flow from the liquid to unit length of element.

∴ the rate of rise of temperature of the element

$$= \frac{\Delta\theta_E}{\Delta T} = \frac{\Delta Q}{\Delta T.C_E} = \frac{\theta_F - \theta_E}{R_F.C_E}$$

$$i.e.,\ \theta_E = -C_E.R_F\frac{d\theta_E}{dT} + \theta_F \qquad \text{.....(1)}$$

A solution of the differential equation (1) is :—

$$\theta_E - \theta_F = (\theta_E{}^\circ - \theta_F{}^\circ)e^{-\frac{T}{C_E.R_F}} - e^{-\frac{T}{C_E.R_F}}\int_0^T \frac{d\theta_F}{dT}.e^{\frac{T}{C_E.R_F}}\,dT$$

.....(2)

where $\theta_F{}^\circ$, $\theta_E{}^\circ$ are the initial temperatures of fluid and element and θ_F, θ_E are corresponding values at time T.

(The step from eq. (1) to eq. (2) must be accepted as a mathematical fact.)

Eq. (2) enables us to predict the lag in response of the bare element under consideration for the three conditions mentioned above, namely :—

(1) θ_F constant $= \theta_F{}^\circ$.

This corresponds to the condition in which the element is plunged into a fluid at a different temperature ($\theta_F{}^\circ$).

(2) θ_F varying at a constant rate, and

(3) θ_F varying sinusoidally.

$\frac{d\theta_F}{dT}$ is the rate of change of θ_F, so that we have :—

Case (1) $\frac{d\theta_F}{dT} = 0$ (since θ_F is constant),

Case (2) $\frac{d\theta_F}{dT}$ = a constant = (say), α, and

Case (3) $\theta_F = \theta_F{}^\circ + A\cos\omega T$

where A = amplitude of the temperature oscillation

and $\frac{2\pi}{\omega}$ = period of oscillation,

giving $\frac{d\theta_F}{dT} = \frac{d}{dT}\ (A\cos\omega T) = -A\omega\sin\omega T$.

We can now substitute in eq. (2) for the three cases

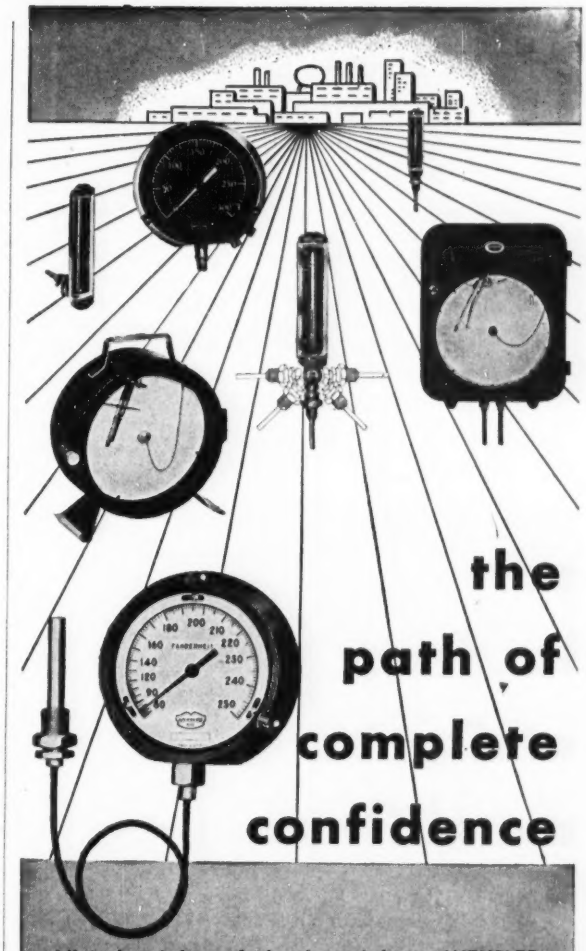
Case 1.— $\theta_F - \theta_E = (\theta_F{}^\circ - \theta_E{}^\circ)e^{-\frac{T}{C_E R_F}}$ .....(3)

If $T = C_E R_F$ then :—

$\theta_F - \theta_E = (\theta_F{}^\circ - \theta_E{}^\circ)e^{-1} = 0{\cdot}368\ (\theta_F{}^\circ - \theta_E{}^\circ)$*

Thus after a time T such that $T = C_E R_F$, the temperature difference between element and fluid will have been reduced by 63·2 per cent.

Continued on next page



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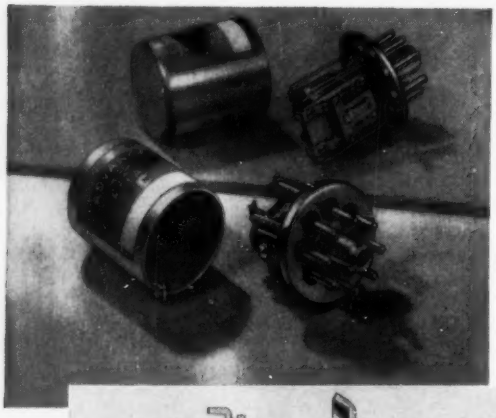

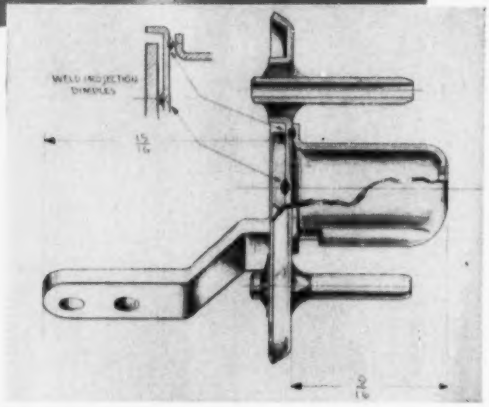

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Note: $C_E R_F$ has the dimensions of time and is known as the time constant of the system. From what follows it will be seen that it is equal to the *time lag* for a linear rate of increase of the fluid surrounding the element.

Case 2.—Putting $\frac{d\theta_F}{dT} = \alpha$, we can obtain from equation (2) :

$$\theta_E - \theta_F = -\alpha(C_E R_F) + (\theta_E - \theta_F + \alpha C_E R_F)e^{-\frac{T}{C_E \cdot R_F}} \ldots (4)$$

The last term decreases as T increases, so that after a suitable time we have the steady condition :—

$$\theta_F - \theta_E = \alpha C_E R_F$$

Fig. 3 shows values of θ_E and θ_F taken from equation (4) plotted against time (T). It is clear that the *measuring* lag is $\theta_F - \theta_E$ which we have just seen is equal to $\alpha . C_E . R_F$. It follows from the figure that the *time* lag (L) is $C_E R_F$.

The point of interest is that in these conditions the lag L is always equal to $C_E R_F$ whatever the rate of rise of temperature. We can therefore define the time lag in a very commonsense way as the time which elapses between θ_F and θ_E reaching the same temperature say θ, when θ_F is increasing at constant rate and conditions have become steady.

It is useful to note that the temperature of the element θ_E at any time differs from the true temperature of the fluid θ_F by an amount $= \alpha \times L$.

Case 3.—If$(-A\omega \sin \omega t)$ is substituted in equation (4) for $\frac{d\theta}{dF}$ and the differential equation is solved for θ_E, then it will be found that θ_F and θ_E follow the temperature/time curves shown in Fig. 4. It will be seen that θ_E lags behind θ_F and also that the amplitude of variation of θ_E is smaller than that of θ_F.

The actual percentage reduction in amplitude is found to be :—

$$\frac{100}{\sqrt{1 + (L\omega)^2}} \quad \text{or} \quad \frac{100}{\sqrt{1 + \left(2\pi \frac{L}{n}\right)^2}}$$

where L = time lag of detecting element and n = period of the process disturbance.

Hence if $L = 4$ min. and the plant is "hunting" with a period of 8 minutes, the amplitude of measured temperature will be only 30 per cent. of that of the actual temperature variation.

The additional difficulty of controlling the process when only 30 per cent. of the temperature change is measured is obvious.

There is, however, another very important reason why the detecting element lag increases the difficulty of control. In Fig. 4 it will be seen that the detecting element signal lags behind the disturbance to the measured condition.

The plot of the detecting element signal is therefore also a sine wave, but both smaller in amplitude and displaced along the time axis. This displacement can be described as a phase lag (ϕ) and its value can be derived from equation (4) as :—

$$\phi = \tan^{-1} \frac{2\pi L}{n} \text{ radians.}$$

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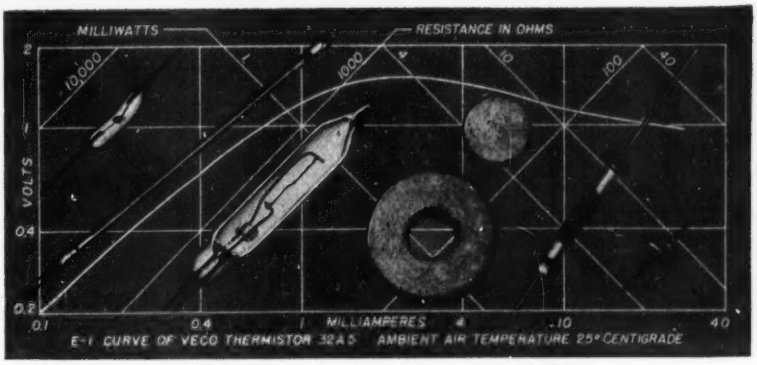

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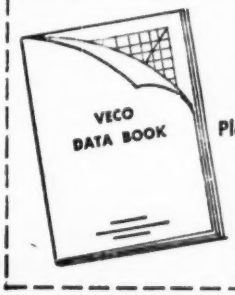

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Temperature

L-122 **Temperature Controller.** New 2-page Bulletin 850 describes and illustrates maker's vapor-actuated electric-contact controllers, including specifications, price, and accessory numbers and prices. Also includes maker's solenoid valves and relays with specifications, dimensions, and prices.—H. O. Trerice Co., 1420 W. Lafayette Blvd., Detroit 16, Mich.

L-123 **Temperature Transmitters.** New 4-page illustrated Bulletin A-706 describes maker's "T2T Temperature Primary Element Transmitter," a resistance-thermometer temperature element designed to operate in conjunction with the Swartwout "Autronic Controlling and Recording System." Includes principles, schematic diagrams, and technical data.—Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio.

L-124 **Test-chamber Instrumentation.** New 4-page Instrumentation Data Sheet 11.0-6 describes instrumentation of environmental test chambers of Hieatt Engineering Co. Includes details of operations, basic instrumentation requirements, and illustrations covering both test chambers and instruments.—Sta. 64, Minneapolis-Honeywell, Brown Div., Wayne & Windrim Aves., Phila. 44, Pa.

L-125 **Miniature Thermostat.** New 2-page Bulletin 36 describes and illustrates maker's miniature sealed-in-glass thermostat. Gives features, applications, and specifications.—Thomas A. Edison, Inc., West Orange, N. J.

L-126 **BTU Meter.** New 2-page Instrumentation Data Sheet 10.19-1 presents principles, operation, and application of BTU meter that records flow, differential temperature of liquid, and BTU's. Suggests applications in heat exchangers, refrigeration, pilot plants, etc.—Sta. 64, Minneapolis-Honeywell Reg. Co., Brown Div., Phila. 44, Pa.

L-127 **Electric Immersion Heaters.** New 4-page Bulletin 15 describes and illustrates maker's "Vitreosil" electric immersion heaters of fused silica for heating acid baths. Includes features, applications, specifications, prices, and acid containers.—The Thermal Syndicate, Ltd., 14 Bixley Heath, Lynbrook, N. Y.

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L-128 **Pressure, Differential Regulators.** New 8-page illustrated Catalog 29 describes new constant-pressure-differential regulator for use with maker's "Purgerator" flowmeter, and also new pressure regulators for instrument air. Includes performance, operation, and specifications.—Fischer & Porter Co., Hatboro, Pa.

L-129 **Blast Gage.** New 2-page bulletin describes maker's "Model P-401" piezoelectric blast gage for evaluation of magnitude and wave shape of sharp transient air blast produced by explosives or other means. New 2-page price list gives model and price listings of Glennite accelerometers, filters, blast gages, cathode followers, amplifiers, and electron-tube test set.—Gulton Mfg. Corp., Metuchen, N. J.

L-130 **Pressure Transmitter.** New 4-page bulletin describes and illustrates maker's new pressure transmitter for measuring fluids with positive seal between receiver and fluid. Includes operation, standard models, specifications, and typical installations.—King Engineering Corp., Ann Arbor, Mich.

L-131 **Pneumatic Pressure Transmitter.** New 2-page Bulletin 780 describes and illustrates maker's pneumatic transmitter comprising pressure gage and pneumatic transmitter. Gives applications, operations, and mounting dimensions.—Penn Industrial Instrument Corp., Penn Bldg., 4110 Haverford Ave., Phila. 4, Pa.

L-132 **Pilot-operated Pressure Regulator.** New 4-page Bulletin 614 describes and illustrates maker's twin-nozzle pilot regulator that controls pressures from ounces to 1,000 psi. Includes dimensions and mention of other products.—Wilgus Manufacturing Co., 1722 E. 16th St., Los Angeles 21, Calif.

L-133 **Hermetic Seals.** New 32-page Catalog S-53 features photos, diagrams, and data concerning over 1600 stock seals and special assemblies. Shows company's line of electronic and electrical control systems, test equipment, components, communication equipment. Includes descriptions and specifications.—Sealtron Co., 9701 Reading Rd., Cincinnati 15, Ohio.

Flow

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L-137 **Orifice Meters, Plates.** New 8-page Bulletin 56-B presents maker's bellows-type differential-unit flowmeters and assemblies. 4-page Bulletin 54-C presents features and prices of orifice plates.—Industrial Instrument Corp., Odessa, Texas.

L-138 **Industrial Flow Meter.** New Bulletin OG-403 describes maker's new stainless-steel industrial meter with max. capacity of 100 gallons per minute at max. working pressure of 125 psi.—Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.

L-139 **Stainless-steel Positive Meter.** New 2-page illustrated Bulletin OG-403 describes new "Rotocycle Type 2BC" stainless-steel industrial meter for corrosive liquids. Includes features and specifications.—Rockwell Mfg. Co., Pittsburgh 8, Pa.

Combustion

L-140 **Oxygen, Combustibles Analyzer.** New 6-page bulletin describes maker's oxygen and combustibles analyzer. Includes application, features, standard ranges, operating characteristics, installation requirements, accessories, and diagrams of systems.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

L-141 **Combustion Control.** New 8-page Vol. 12, No. 3 issue of "Modern Precision" features articles on combustion control, and on instrumentation in the fields of metals, industrial wastes, process industries, power, research, teaching and testing.—Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.

L-142 **Combustion Control,** New Dec., 1952 issue of "Wheelco Comments" contains three articles on uses of maker's combustion and heat-treating control equipment in typical industrial applications.—Wheelco Div., Barber-Colman Co., Rockford, Ill.

L-143 **Furnace Atmosphere Control.** New 4-page bulletin is a technical report on maker's "Carbotrol" for accurate control of carbon potential of furnace atmospheres. Includes principle, operation, application, and illustrations.—Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12, Ill.

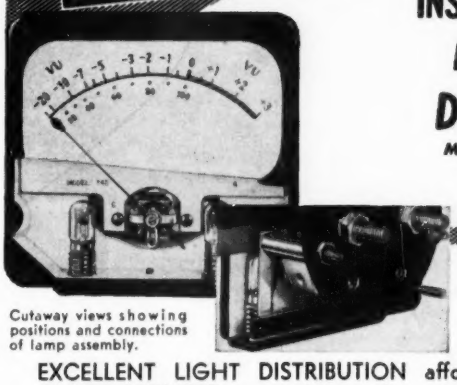
L-144 **Ovens.** New 12-page bulletin features a mythical oven experience plus scientific air data. Includes operating principles and features of maker's ovens that deliver constant weight of air at all temperatures.—Blue M Electric Co., 306 W. 69 St., Chicago, Ill.

Process Control

L-145 **Power Transducers for Process Control.** New 14-page Bulletin 15-16 contains technical data on application of

Burlington

ILLUMINATED INSTRUMENTS FOR VU-DB-DBM Measurement



Cutaway views showing positions and connections of lamp assembly.

Available in all ranges 3½" and 4¼" rectangular semi-flush models.

EXCELLENT LIGHT DISTRIBUTION affords EASE IN READING. GLARE REDUCED to a minimum by retaining COMPACT DESIGN of front case extension.
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Two 3.8 volt STANDARD BULBS are used and connected in series.
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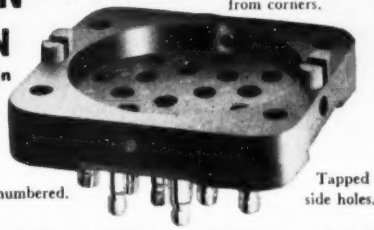
When designing any plug-in unit REACH FOR THIS BASE

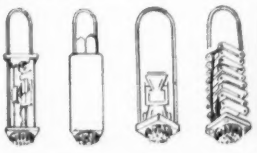
ALDEN 20-PIN
Also 11-pin & MIN. 7 & 9-pin


Molded boss to hold mounting cards.
Holes to take brackets or bail, kept well away from corners.
All prongs numbered.
Tapped side holes.

DESIGNED SPECIFICALLY FOR PLUG-IN UNIT CONSTRUCTION

TREMENDOUS FLEXIBILITY

Bases are complemented by standard Alden components: handles, brackets, housings, terminal cards to lick almost any problem.



Non-Interchangeable Color Coded

Choice of variable pin patterns guarantees against mismating. Color coding directs plug-in to its correct socket.

Also 20-pin, 11-pin, 9-pin, 7-pin MATING SOCKETS
Request free samples and free 226-page "Alden Handbook" of Plug-In Unit Construction.
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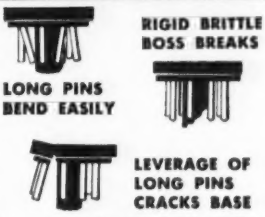

Are you tired of throwing away perfectly good units on account of broken bases?

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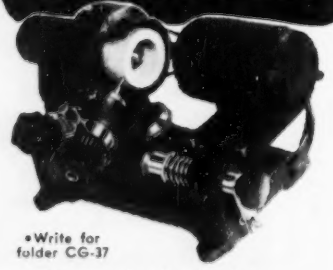

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- Ball bearing grinding spindle.
- Tool head indexed for single lip and 2, 3, 4-sided cutters.

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power-measurement transducers to process control. Includes descriptions of applications of thermal converters, solenoid-plunger ammeter, torquemeter, vacuum thermocouple, rectifying current system, precision shunt, saturable reactor, and magnetic amplifier. Sta. 64, Minneapolis-Honeywell, Brown Div., Wayne & Windrim Aves., Phila. 44, Pa.

L-146 **Process Cut-off Relay.** New 2-page Bulletin 8504 describes relay for use in electric control circuits to shut down process when predetermined control point is reached. Includes applications, specifications, and installation.—Sta. 64, Minneapolis-Honeywell Reg. Co., Brown Div., Phila. 44, Pa.

L-147 **Cupola Air-weight Control.** New 2-page Application Engineering Data Sheet 330-6 describes and illustrates maker's air-weight control for foundry cupolas. Includes principle, application, and operation.—The Foxboro Co., Foxboro, Mass.

L-148 **Control Equipment.** New revised Section 105 and 110 for "Climax Controls Catalog" describe and illustrate diaphragm control valves and pilots and controllers. Includes detailed specifications, applications, and ordering information.—Black, Sivalls & Bryson, Inc., 7500 E. 12 St., Kansas City 26, Mo.

L-149 **Level Control.** New 8-page illustrated Bulletin F-101 describes maker's "Tektor" electronic level controller for liquids or solids. Includes features, applications, and specifications.—Fielden Div., Robertshaw-Fulton Controls Co., 2920 N. 4 St., Phila., Pa.

L-150 **Power-press Control.** New 2-page bulletin describes and illustrates maker's "curtain of light" photoelectric safety guard for power presses. Includes operation, benefits, features, and standard units.—Electronic Control Corp., 1573 E. Forest Ave., Detroit 7, Mich.

L-151 **Contact Meter-relays.** New 4-page Bulletin CMR-79 describes maker's contact meter-relays. Includes specifications, features, dimensions, prices, and ordering information.—Assembly Products, Inc., Main & Bell Sts., Chagrin Falls 1, Ohio.

Computing, Counting

L-152 **Analog Data Recorder, Printer.** New 4-page Bulletin K52 describes and illustrates maker's analog data recorder for numerical printing of analog quantities. Includes applications, operation, and features. — Streeter-Amet Co., 4101 Ravenswood Ave., Chicago 13, Ill.

L-153 **Electronic Counter.** New 4-page issue Vol. 4 No. 3 of "hp Journal" contains article on "A New 100 KC Counter For Electronics and Industry." Includes principles, applications, and specifications.—The Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

L-154 **Scalers, Totalizers, Counters.** New 2-page illustrated bulletins describe maker's (1) all-purpose laboratory poli-scaler, (2) high-speed scaler, (3) decimal totalizer, (4) Geiger Counter. Includes features and specifications. —The Detectron Co., 5631 Cohuenga Blvd., N. Hollywood, Calif.

L-155 **Computing, Data Handling.** New 4-page illustrated brochure presents features of maker's "Computyper" for high-speed recording of numerical data, "Dactylograph" for automatic plotting, and "Photoformer" for nonlinearity correction and function generation. Other analog and digital equipments are described briefly.—Benson Lehner Corp., 2340 Sawtelle Blvd., Los Angeles 64, Calif.

L-156 **Schedule Computer.** New 4-page bulletin describes and illustrates maker's quality and production-control computers for controlling production schedules. Includes features, applications, operation, installation, and specifications.—Industrial Computer Corp., 272 Lembeck Ave., Jersey City, N. J.

L-157 **Computer Resolver Systems.** New 4-page bulletin describes and illustrates maker's resolver systems for resolving vectors into their sine and cosine components. Includes applications, specifications, dimensions, technical data, and reference drawing numbers.—Ford Instrument Co., 31 Thomson Ave., L. I., N. Y.

L-158 **Computers.** New 64-page Jan., 1953 issue of "General Electric Review" features 1952 progress stories on computers, nucleonics, electronics, chemical fields, industry, and other fields.—General Electric Co., Schenectady, N. Y.

L-159 **Bacteria-colony Marker, Counter.** New 2-page bulletin describes and illustrates maker's electrically controlled marker that tallies and summarizes each time a bacteria colony is marked. Includes prices.—Kleet Mfg. Co., 179 E. 87 St., New York, N. Y.

L-160 **Analog-digital Converter.** New bulletin presents features of maker's d. c. to decimal converter that consists of necessary circuitry for analog-to-digital conversion.—Benson-Lehner Corp., 2340 Sawtelle Blvd., Los Angeles 64, Calif.

Radioactivity

L-161 **Nucleonic Density Gages.** New 4-page Bulletin 104 describes maker's density gages for measuring process variables by radioactivity technique. Includes applications and general characteristics.—The Ohmart Corp., 2347 Ferguson Rd., Cincinnati 38, Ohio.

L-162 **Gamma Radiation.** New 4-page bulletin describes and illustrates maker's "Gammometer" for direct measurement of gamma-ray emission. Includes specifications and dimensions.—The Ohmart Corp., 2347 Ferguson Rd., Cincinnati 38, Ohio.

Testing, Inspection

L-163 **Testing Machines.** New 4-page Bulletin 4204 describes and illustrates new improved models of Baldwin "60-H and 12-H" low-cost universal testing machines. Includes loading system and specifications.—Baldwin-Lima-Hamilton Corp., Phila. 42, Pa.

L-164 **Inspection Equipment.** New 8-page illustrated bulletin describes more than 80 inspection and quality-control aids, including stereomicroscopes, illuminating magnifiers, comparators, etc. Includes newest developments.—Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.

L-165 **Inspection Light.** New 4-page bulletin describes and illustrates maker's "Flash-O-Lens" illuminated magnifier for inspection. Includes applications, advantages, models, and prices.—E. W. Pike & Co., 492 North Ave., Elizabeth 3, N. J.

L-166 **Paint Hiding-power Testing.** New 4-page bulletin describes and illustrates "Pfund Cryptometer" to determine paint hiding-power ability. Includes available types, applications, and prices.—Gardner Laboratory Inc., 4723 Elm St., Bethesda 14, Md.

L-167 **Gloss Measurement.** New 4-page bulletin describes and illustrates maker's precision gloss-measuring unit with gloss heads for 20, 45, 60, 75 and 85 degrees. Includes applications, operations, and prices.—Gardner Laboratory, Inc., 4723 Elm St., Bethesda 14, Md.

L-168 **Cotton-fiber Blender.** New 2-page bulletin describes and illustrates maker's USDA mechanical cotton-fiber blender that blends 10 grams of cotton, sufficient for laboratory tests, in one-tenth time of hand-blending method. Includes dimensions and weight.—Thwing-Albert Instrument Co., Penn St. at Pulaski, Phila. 44, Pa.

Gaging

L-169 **Gaging.** New 24-page Catalog 53 covers entire line of reversible go and no-go plug gages, reversible thread gages, centerless lapping machines, and all AGD gages. Features sections on facilities for special gage development and protection, metallurgical research laboratory, and instruments for precision measuring and checking.—Size Control Co., Div. American Gage & Machine Co., 2500 W. Washington Blvd., Chicago, Ill.

L-170 **Gage Blocks.** New 36-page catalog contains information on how to use gage blocks—how they are made; physical characteristics; how to use the accessories; care of blocks; and how to measure angles. Write on company letterhead to—Webber Gage Co., 12900 Triskett Rd., Cleveland 11, Ohio.

L-171 **Continuous Gaging.** New 28-page catalog describes and illustrates maker's line of gages and control units for production control of thickness, width, etc. Includes applications and specifications for mechanical gaging, beta-ray gaging, foil gaging, mill gaging, wire gaging, totalizing, and warning devices.—Pratt & Whitney, West Hartford 1, Conn.

L-172 **Gages, Machine Tools, Comparators.** New 8-page bulletin describes and illustrates maker's machine tools, cutting tools, gages, and other products. Includes ordering information.—Pratt & Whitney, West Harford 1, Conn.

Optical

L-173 **Ephemeris.** New 100-page 1953 edition of "Gurley Ephemeris"

Basically, the Flex-Valve is just a piece of flexible tubing and a clamp to squeeze it shut. It can no more clog than a length of pipe. So, if you can clog one of them in normal service, just tell us, for the "incredible-but-true" record, how in the world you did it, and we'll send your money back.

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lists 28 selected stars for determining azimuth by stellar observations. Includes definitions of astronomical terms, descriptions of methods of observation, and examples of reducing data for determining a true meridian.—W. & L. E. Gurley, Troy, N. Y.

L-174 **Microscope.** New 14-page bulletin describes and illustrates maker's "Dialux" microscope with built-in illumination. Includes specifications, accessories, prices.—E. Leitz, Inc., 304 Hudson St., New York 13, N. Y.

L-175 **Levels, Transits.** New 6-page folder describes and illustrates five models of maker's surveying and contouring instruments. Includes applications, operation, prices, and bulletin numbers.—David White Co., Milwaukee, Wis.

L-176 **Interference Filters.** New 4-page Bulletin D-248 describes maker's transmission-type interference filters. Includes principles, specifications, prices, and ordering information.—Bausch & Lomb Optical Co., Rochester 2, N. Y.

Analytical

L-177 **Mass-spectrometer Stream Analysis.** New 12-page issue Vol. 6, No. 4 of "CEC Recordings" contains ten illustrated articles on continuous mass spectroscopy at ESSO, vibration testing and monitoring, process control, etc.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

L-178 **Infrared Gas Analyzers.** New 14-page brochure describes and illustrates maker's "Model 15" gas analyzer that operates on infrared asorption principle. Includes principle, operation, applications, specifications, accessories, and quotation request sheet.—Liston-Becker Instrument Co., Inc., Stamford, Conn.

L-179 **Colorimeter.** New 4-page bulletin describes and illustrates maker's 50 and 100 mm. colorimeter for blood chemistry. Includes specifications, accessories, and prices.—Klett Mfg. Co., 179 E. 87 St., New York, N. Y.

L-180 **Analytical Chemistry.** New 98-page Vol. 41, No. 4 issue of "Chemist Analyst" features 6 articles on volumetric determination of zinc, hardness of water, polarographic cells, boronimeters, etc. Also 8 laboratory suggestions.—J. T. Baker Chemical Co., Phillipsburg, N. J.

Chemical Laboratory

L-181 **Petroleum Testing Equipment.** New 44-page Catalog 53 is descriptive inventory of comprehensive Fisher/Tag line of modern oil-testing equipment from A (asphalt softening-point apparatus) to Z (Zahn viscometer).—Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

L-182 **Stirrer.** New 2-page bulletin describes and illustrates maker's "Hollow Spindle" stirrer with sparkless shaded-pole motor. Gives applications, operation, specifications, and price.—Eberbach Corp., Ann Arbor, Mich.

L-183 **Greaseless Stopcock.** New 2-page bulletin describes and illustrates maker's greaseless stopcock for gas and liquid flow where absence of grease is a factor. Gives operation and ordering information.—Laboratory Equipment Corp., St. Joseph, Mich.

L-184 **Electrode Plater.** New 2-page bulletin describes and illustrates maker's electrode plater for plating platinum electrodes for chemical analysis. Includes features, applications, and price.—Laboratory Equipment Corp., St. Joseph, Mich.

L-185 **Micro-freezing Stage.** New 6-page bulletin describes and illustrates the Kofler micro freezing stage. Includes applications, features, price.—William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.

L-186 **Burettes.** New 2-page Bulletin 387 describes and illustrates maker's "Teflomatic" burettes featuring solid Teflon plugs, and Teflon-coated joints.—Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.

L-187 **Vitreous Crucibles, Retorts.** New 4-page bulletin describes and illustrates maker's vitreous silica containers. Includes dimensions, specifications, and prices.—The Thermal Syndicate, Ltd., 14 Bixley Heath, Lynbrook, N. Y.

L-188 **Vitreous Laboratory Ware.** New 8-page Bulletin 18 describes and illustrates maker's fused quartz and fused silica, transparent and non-transparent, tubing, rods, and laboratory ware. Includes characteristics and prices.—The Thermal Syndicate, Ltd., 14 Bixley Heath, Lynbrook, N. Y.

Recording

L-189 **Electronic Recorders.** New 12-page folder ND46 (1) presents brief history and principles of maker's "Speedomax" recorders—X-Y, X_1-X_2 or adjustable-range adjustable-zero, power-level, precision range extension, and photomultiplier-tube types. Includes spans and pickups.—Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.

L-190 **Recording Systems.** New 26-page catalog describes and illustrates maker's industrial recording systems and amplifiers. Includes performance characteristics, frequency response curves, prices, and representatives—Sanborn Co., Industrial Div., Cambridge 39, Mass.

L-191 **Strain Recording.** New 12-page Vol. 2, No. 2, issue of "Hathaway Engineering News" features article on new "MRC-21" strain-gage control unit for airborne and mobile applications. Other articles are on oscillograph, strain measurement, and strain recording.—Hathaway Instrument Co., 1315 S. Clarkson St., Denver 10, Colo.

L-192 **Oscillograph Trace Reader.** New 2-page bulletin describes maker's new "Model C" portable oscillograph trace reader designed to expedite analysis of continuous trace records on film or paper. Includes specifications.—Benson-Lehner Corp., 2340 Sawtelle Blvd., Los Angeles 64, Calif.

L-193 **Graphic Recording.** New 16-page booklet "Solving Industrial Crimes—Case No. 42" contains applications of

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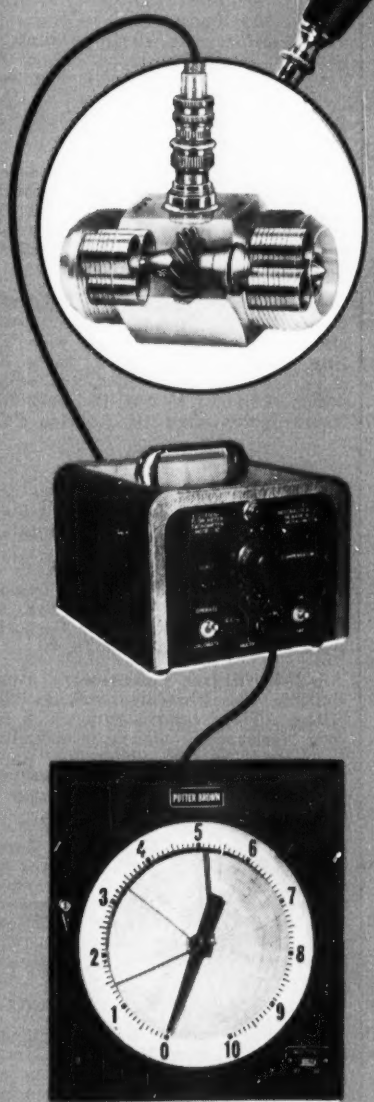

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The basis for all Potter Flow Metering Systems is the unique turbine-type rotor, which is designed so that it spins—without slippage or friction—at a rate that is proportional to the flow through the unit. The Sensing Element contains a small permanent magnet, which induces an alternating voltage in a pickup coil mounted outside the housing. The frequency of this voltage is linearly proportional to flow over ranges as great as 25-1.

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The Potter Converter produces a smooth dc output which is proportional to the frequency of the ac input from the Sensing Element. The unit is easily calibrated, using an internal frequency standard, and has a fast response speed which permits its use for the measurement of rapidly-changing flows. Available with built-in totalizer in multiple-input models and with specific gravity compensation for the measurement of mass flow.

Accuracy of the system will be well within ½ % of true flow over the normal operating range.

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The Sensing Element and Converter will operate any standard indicating or recording instrument having a span of 0-1 ma and a nominal internal resistance of 50 ohms. Any evenly-graduated chart or scale can be used to read directly in flow units.

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recording instruments for monitoring various industrial operations.—The Esterline Angus Co., Inc., Indianapolis, Ind.

Valves

L-194 **Butterfly Control Valves.** New 4-page Bulletin 8503 describes butterfly valves designed to regulate flow of air, gas, liquids or steam in conjunction with indicating, recording or non-indicating pneumatic controllers. Includes application data, specifications, dimensions, sizing data.—Sta. 64, Minneapolis-Honeywell, Brown Div., Wayne & Windrim Aves., Phila. 44, Pa.

L-195 **Rotary-stem Valves.** New 4-page Specification Sheet 423 illustrates and describes Honeywell "Type 33" double-seated rotary-stem regulating valves for on-off or narrow-band proportional control. Includes size, construction, ratings, and C_v.—Minneapolis-Honeywell, Brown Div., Sta. 64, Phila. 44, Pa.

L-196 **High-pressure Solenoid Valves.** New 4-page brochure illustrates and describes typical applications of maker's solenoid-operated valves for high-pressure lines. Includes design and size data.—Atkomatic Valve Co., Dept. 138, 545 W. Abbott St., Indianapolis, Ind.

L-197 **Solenoid Valves.** New 4-page Bulletin 500 describes and illustrates maker's solenoid-operated valves. Includes types, operation, specifications, and prices.—J. D. Gould Co., 730 E. Washington St., Indianapolis 2, Ind.

L-198 **Tight-shut-off Valve.** New 2-page bulletin describes and illustrates maker's "Throttleseal" valve with "O"-ring seal. Includes types, parts list, sizes, weights, dimensions, and prices.—Daniel Orifice Fitting Co., Inc., 3346 Union Pacific Ave., Los Angeles, Calif.

Air, Water

L-199 **Instrument Air Cleaner.** New 2-page bulletin describes and illustrates maker's "Model B-30-D Condensifilter" with new disposable filter cartridge, said to provide instrument-quality air for all compressed-air applications. Gives applications, specifications, and component parts.—Hankison Corp., 951 Banksville Rd., Pittsburgh 16, Pa.

L-200 **Oil-free Compressors.** 4-page Bulletin 600 illustrates and describes "Class ATCL" compressors which feature steel-backed carbon cylinder-liner to produce oil-free compressed air or gas. Includes cut-a-way view, features, and design.—Pennsylvania Pump & Compressor Co., Easton, Penna.

L-201 **Water Conditioning.** 4-page illustrated bulletin gives features and specifications of "Uniflow" equipment for water softening, filtration, and iron removal. Includes capacities and analysis service.—Uniflow Mfg. Co., Erie, Penna.

Electronic Test Equipment

L-202 **Electronic Test Equipment, Components.** New 196-page Catalog H-53 (1953) contains illustrations and descriptions of thousands of items handled by large distributor of test equipment and electronic components.—Hudson Radio & Television Corp., 48 W. 48 St., New York 36, N. Y.

L-203 **Complete Audio Catalog.** New 132-page audio-equipment catalog is said to be "largest and most comprehensive catalog ever compiled to deal exclusively with audio equipment." Includes high fidelity home music system components, public address, institutional, recording and broadcast equipment, and audio test instruments.—Terminal Radio Corp., 85 Cortlandt St., New York 7, N. Y.

L-204 **Oscillographs.** New 20-page Vol. 13, No. 2 issue of the "Oscillographer" features articles on "Techniques of Measurement in Oscillography" and an article on maker's "Type 322" dual-beam general-purpose oscillograph. Includes specifications.—Allen B. DuMont Laboratories, Inc., Inst. Div., 1500 Main Ave., Clifton, N. J.

L-205 **Test Instruments.** New 32-page 1953 Catalog illustrates and describes maker's large line of electronic test instruments available in kit form. Includes circuits and specifications.—The Heath Co., Benton Harbor, Mich.

L-206 **Comparison Bridge.** New 8-page Vol. 27, No. 7 issue of "The General Radio Experimenter" illustrates and describes new "Type 1604-A" comparison bridge for rapid testing of electronic components. Includes principles, circuit, operation, and specifications.—General Radio Co., Cambridge, Mass.

L-207 **Capacitance Meters.** New Vol. 17, No. 12 issue of "The CD Capacitor" features 4-page article on capacitance meters, plus 2-page article on selenium rectifiers. Also "Radio Trading Post."—Cornell-Dubilier Electric Corp., Hamilton Blvd., S. Plainfield, N. J.

L-208 **Test Instruments.** New 4-page index is chronological index, subject index, and model-no. index of electronic test instruments described in Vols. 1-3 of the "hp Journal."—The Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

L-209 **Standard Signal Generators.** New 4-page bulletin describes and illustrates maker's "Model 30" standard signal generator for 40-400 Mc. Also "Model 20" for from 85 kc. to 40.0 Mc. Includes output, modulation, circuit, shielding, tubes, size, and weight.—The Rollin Co., 2010 Lincoln Ave., Pasadena 3, Calif.

L-210 **Ruggedized Electrical Indicators.** New 4-page Bulletin PM2 describes and illustrates maker's ruggedized, glass-to-metal, hermetically sealed electrical indicating instruments; includes construction, available sizes, and results of shock test. New 2-page brochure describes ruggedized laboratory-type voltmeters and current meters.—Phaostron Co., 151 Pasadena Ave., South Pasadena, Calif.

L-211 **Isolation Amplifier.** New 4-page Bulletin 1 describes and illustrates maker's "Universal a-c. Isolation Amplifier Type 1-A, Model 1" for use in driving resolvers and computing potentiometers. Includes applications, speci-

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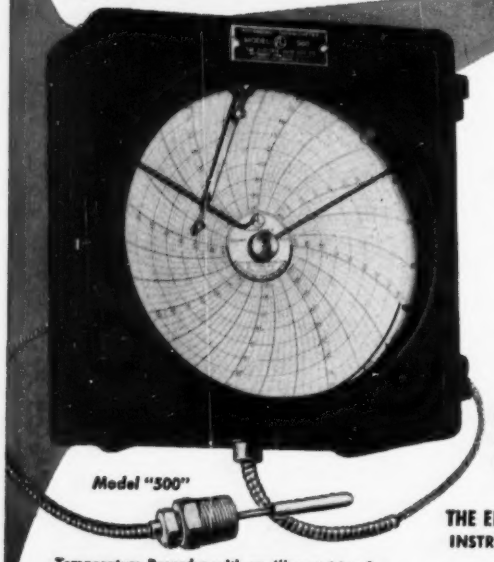

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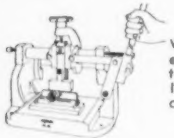

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NEW LITERATURE

fications.—Seay Instrument Co., 6521 N. Lamar Blvd., Austin 5, Texas.

L-212 **Amplifiers, Filters.** Five 2-page illustrated brochures describe maker's high-impedance voltage and current amplifiers, cathode followers, and low-pass filters.—Gulton Mfg. Corp., Metuchen, N. J.

L-213 **Valve, Pipe-leak Detector.** New 4-page illustrated brochures describe maker's metal detector for pipes and valves; also audio-type pipe-leak detector. Includes specifications.—The Detectron Co., 5631 Cahuenga, N. Hollywood, Calif.

L-214 **Earth Voltage Measurement.** New 2-page Bulletin 101 describes and illustrates maker's new "Geovolt" apparatus for searching for earth deposits, geologic studies, etc. Includes components, principle of operation, and typical operating technique.—Geophysical Instrument Co., Div. of Georator Corp., Arlington 9, Va.

L-215 **Noise Probe.** New 4-page bulletin describes and illustrates maker's electronic trouble spotter that locates, analyses, and compares vibrations and noises in mechanical devices, motors, pipes, etc. Includes applications, specifications, and price.—Erwood Inc., 1770 Berteau St. Chicago 13, Ill.

L-216 **Resistance Testing.** New Bulletin 10AA is quick-reference data sheet covering maker's line of test instruments for insulation resistance, ground resistance, high voltages, and current transformers.—Associated Research, Inc., 3758 W. Belmont Ave., Chicago 18, Ill.

L-217 **Slotted Line, VSWR Indicator.** New 4-page bulletin describes and illustrates maker's precision slotted line and VSWR indicator that measures impedance, VSWR, and relative power from 100 to above 1000 Mc. Includes operation, performance charts, tube complement, and components.—The Rollin Co., 2010 Lincoln Ave., Pasadena 3, Calif.

L-218 **Electrostatic Locator.** New 2-page Bulletin S155 describes and illustrates maker's "Type-D" electrostatic locator that detects electrostatic charges and electrostatic induction. Includes applications and operation—Specialties, Inc., Skunks Misery Rd., Syosset, L.I., N. Y.

L-219 **400-cycle Generator.** New 2-page Bulletin E10 describes and illustrates maker's 400-cycle generator that has no brushes. Includes features, sizes and weights of generators, "Nobrush" construction, and available types.—Georator Corp., Electric Products Div., Arlington 9, Va.

L-220 **Flight Simulator.** New 4-page Vol. 9, No. 6 issue of "The Connecting Link" describes and illustrates latest company-related news, with feature story on new stratojet flight simulator.—Link Aviation, Inc., Birmingham, N.Y.

L-221 **Test Light.** New 2-page Bulletin L-2A describes and illustrates maker's industrial "Test-Glo" test light for testing electrical circuits, spark-

plugs, motors, fuses, etc. Also includes description and illustrations of maker's "Flur-test" fluorescent-fixture testers. —Ideal Industries, Inc., Sycamore, Ill.

L-222 **Variable Filters.** New 2-page Bulletin C1021 describes and illustrates maker's variable high- and low-pass filters for sound and electronic laboratory research and control. Includes dimensions, weight, and price.—Cinema Engineering Co., 1510 W. Verdugo Ave., Burbank, Calif.

Motors, Speed Changers

L-223 **Fractional-hp. Motors.** New 4-page "Motorgram" Vol. 32, No. 6. features articles on use of motors in testing strength of sand, in tape recording, and on selection of motor bearings.—Bodine Electric Co., 2250 W. Ohio St., Chicago 12, Ill.

L-224 **Shaded-pole Motors.** New 4-page Motor Sheet F 4271-2 describes large line of unidirectional, reversible, and synchronous "Barcol" shaded-pole motors for servomechanisms, industrial instruments, etc. Includes features, diagrams, and specifications.—Barber-Colman Co., Motor Div., Rockford, Ill.

L-225 **Permanent-magnet Motors.** New 4-page Bulletin F4344 describes and illustrates maker's p-m. motors with balanced armature for low noise level, high efficiency, and long brush life.—Barber-Colman Co., Motor Div., Rockford, Ill.

L-226 **Motors, Betatrons.** New 36-page 3rd-quarter edition of "Allis-Chalmers Electrical Review" illustrates and describes maker's 24-million-volt betatron for inspection, and 6-page article on complete line of power-plant motors. Also article on dynamic performance of a synchronous-generator voltage regulator.—Allis-Chalmers, Milwaukee 1, Wis.

L-227 **Miniature Variable Speed Changers.** New 4-page Bulletin 99 describes and illustrates maker's miniature variable speed changers that weigh only 6 ounces. Includes application, types, specifications, and ordering information.—Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.

L-228 **Reed-controlled Motors, Timers.** New 4-page bulletin describes and illustrates maker's self-starting, lightweight reed-controlled d-c. motors and timers. Includes specifications and characteristic charts.—Amglo Corp., 2037 W. Division St., Chicago 22, Ill.

L-229 **Motors.** New 4-page condensed price list includes wound rotor, induction, gear, single-phase, and squirrel-cage induction motors. Gives dimensions, controls, and other products.—Century Electric Co., 1806 Pine St., St. Louis 3, Mo.

L-230 **Motor Selector.** New slide rule provides information on 35 of maker's fractional-hp. motors from 1/2000 to ½ hp. Gives vital statistics and specifications contained in company catalog.—Howard Industries, Inc., Racine, Wis.

Tachometers

L-231 **Tachometers.** New 4-page Vol. 8, No. 3 issue of "Biddle Instrument News" features an article on production testing with maker's resonant-reed

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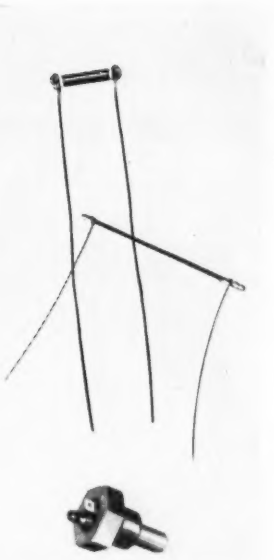

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NEW LITERATURE

tachometers. Includes information on available bulletins.—James G. Biddle Co., 1316 Arch St., Phila. 7, Pa.

L-232 **Speed Measurement.** New 2-page Bulletin 12AA describes and illustrates maker's rotational and lineal speed-measuring tachometers. Includes characteristics and ranges.—Associated Research, Inc., 3758 W. Belmont Ave., Chicago 18, Ill.

Power Supplies

L-233 **Regulated Power Supplies.** New 2-page bulletins describe and illustrate maker's "Model 32A" regulated power supply that provides 160 to 325 volts d.c. at 0 to 200 ma., and "Model 300A" regulated power supply that has an output voltage of 0 to 500 volts d.c. at 0 to 300 ma. Gives specifications and price.—Universal Electronics Co., 2012 S. Sepulveda Blvd., Los Angeles 25, Calif.

L-234 **Power Supplies.** New 4-page bulletin describes and illustrates maker's electronically stabilized power supplies. Includes features and electrical and mechanical specifications.—Power Designs Inc., 119 Atlantic Ave., Richmond Hill 19, N. Y.

L-235 **Klystron Power Supplies.** New 4-page bulletin describes and illustrates maker's electronically regulated "Models 910 and 2310" Klystron power supplies. Includes features, specifications, and weights.—Furst Electronics, 3322 W. Lawrence Ave., Chicago 25, Ill.

Solenoids, Relays

L-236 **D-c. Solenoids.** New 72-page Third Edition of Bulletin DCS3-1952 shows 82 types of solenoids in 5 shell diameters and 25 different coil windings for intermittent and continuous duty. Includes photographs, dimensional sketches, sectional views, charts and applications. Also duty cycle, rated voltage, stroke, current drain, ambient temperature, and tractive force.—Cannon Electric Catalog Dept., 420 West Avenue 33, Los Angeles 31, Calif.

L-237 **Solenoids.** New 40-page revised catalog "PSP Aircraft Quality Solenoids" contains data on selection, classification and limitation of solenoids. Also data and specification sheets on more than 20 d-c. pull, d-c. push, and special-model solenoids.—PSP Engineering Co., 8420 Otis St., South Gate, Calif.

L-238 **Magnetic Relay.** New 2-page Bulletin 3004E describes and illustrates maker's sensitive magnetic relay that is said to withstand sustaining operating power overloads of more than 10,000 times normal rating, and which operates on input of 25 microwatts. Gives types, characteristics, and operating values.—Thomas A. Edison, Inc., West Orange, N. J.

L-239 **Mercury Plunger Relays.** New 4-page brochure illustrates and describes maker's line of mercury plunger relays for loads up to 35 amps at 115 volts, or 25 amps at 230 volts a.c. Includes principle and features.—Ebert Electronics Co., 185-09 Jamaica Ave., Hollis 7, N. Y.

L-240 **Thermal Time-delay Relay.** New 4-page Bulletin 3007C describes and illustrates maker's "Model 501" vibration-resistant thermal time-delay relay. Lists features, operating values, typical applications, general specifications, and types.—Thomas A. Edison, Inc., West Orange, N. J.

L-241 **Miniature Relays.** New 2-page folder shows tests and applications of maker's miniature relays.—Neomatic, Inc., Los Angeles 45, Calif.

Resistors, Potentiometers

L-242 **Resistors, Components.** New 20-page Catalog 53 presents maker's large line of resistors, potentiometers, rheostats, ballast tubes, and line regulators. Includes mechanical and electrical specifications.—Clarostat Mfg. Co., Inc., Dover, N. H.

L-243 **Wire-wound Resistors.** New 2-page Bulletin L-27 describes and illustrates maker's precision wire-wound resistors designed for military specifications. Includes cross-reference table and table for selection of resistance alloy.—Shallcross Mfg. Co., Collingdale, Pa.

L-244 **Multi-turn, Continuous Potentiometers.** New 2-page Catalog Supplement 8-A describes and illustrates maker's new "Type CR" continuous-rotation potentiometer, and "Standard Series" multi-turn pots, including specifications, dimensions, and prices.—Ford Engineering Co., Upland, Calif.

L-245 **4-Watt Resistor.** New 2-page Bulletin P-1 describes and illustrates maker's new IRC "Type PW4" 4-watt resistor with axial leads. Includes applications, constructions, specifications, and representatives.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.

L-246 **Resistors, Potentiometers.** 2-page Dec., 1952 issue of "The Ohmite News" features article on use of maker's composition resistors and "Type AB" potentiometers in quality electronic equipment. Other articles are on thin resistors, cages, and precision resistors.—Ohmite Mfg. Co., 4835 Flournoy St., Chicago, Ill.

L-247 **Carbon Film Resistors.** New 4-page bulletin describes and illustrates maker's precision microcrystalline carbon film resistors. Includes dimensions, construction, high-frequency effects, voltage ratings, and test data.—Chase Resistor Co., 9 River St., Morristown, N. J.

L-248 **Resistors.** New 2-page Bulletin 1861 illustrates and describes maker's "Tru-Mite" wirewound precision resistors. Gives construction details, features, and specifications.—Gorman Mfg. Corp., 2240 Sepulveda Blvd., Los Angeles 64, Calif.

L-249 **Potentiometers.** New 6-page illustrated Brochure 10952 describes unitized construction of maker's line of precision potentiometers including applications, specifications and operations.—Servotrol Co., 114 W. Illinois St., Chicago 10, Ill.

L-250 **Loading Resistor.** New 2-page Bulletin SA 7004 illustrates and describes maker's "Type TT 148" loading resistor for up to 2500-hp tests.

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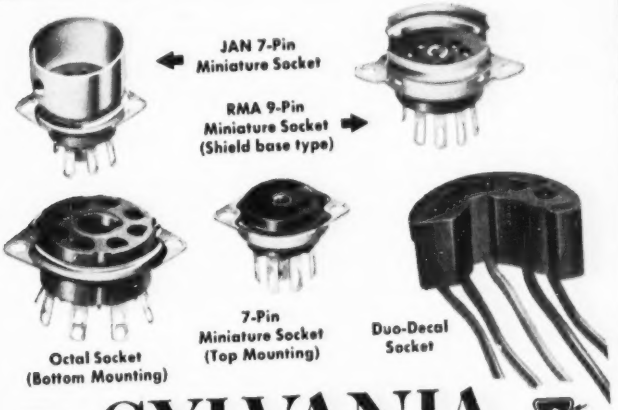
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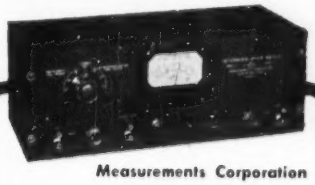

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NEW LITERATURE

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Capacitors, Inductors

L-251 **Tantalum Capacitors.** New 4-page Bulletin 6.100 lists and describes line of tantalum electrolytic capacitors ranging from 1.5 to 30 microfarads, with working voltages up to 125 volts d.c. Also lists 22 standard capacitors, and curves showing capacity and equivalent series resistance in relation to temperature and frequency.—Fansteel Metallurgical Corp., N. Chicago, Ill.

L-252 **Capacitors, Filters.** New 20-page Vol. 17, No. 11 issue of "The C-D Capacitor" contains article on electronic filters, including basic filter techniques and circuits. Also descriptions of maker's capacitors and "Trading Post" section.—Cornell-Dubilier Electric Corp., Hamilton Blvd., S. Plainfield, N. J.

L-253 **Capacitors, Intermodulation** New 20-page Vol. 17, No. 10 issue of "The C-D Capacitor" contains article on the nature and methods of intermodulation measurement. Also descriptions of maker's capacitors and "Trading Post" section.—Cornell-Dubilier Electric Corp., Hamilton Blvd., S. Plainfield, N. J.

L-254 **Precision Ceramic Capacitors.** New 4-page Engineering Bulletin 607-A shows minimum and maximum capacitances available in standard temperature coefficients. Lists standard capacitance tolerances and temperature coefficient tolerances in which metal-encased precision ceramic capacitors are furnished.—Sprague Electric Co., North Adams, Mass.

L-255 **Standard Inductors.** New 8-page issue Vol. 27, No. 6 of "General Radio Experimenter" features article on new series of standard inductors. Includes articles on calibration-check service for sound meters, basis for field-checking sound-meter calibration, and useful "Variac" circuits.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

L-256 **Low-frequency Transformers.** New 8-page brochure illustrates and describes maker's line of low-frequency transformers and reactors with high inductances. Includes construction features, applications, and specifications.—Southwestern Industrial Electronics Co., Inc., 2831 Post Oak Rd., Houston 19, Texas.

L-257 **Subminiature Pulse Transformers.** New 4-page Data Sheet 23 describes and illustrates maker's "A1412 and A1413" subminiature pulse transformers for pulses of 1 and 5 microsec. Includes size and shape, weight, electrical characteristics, and price.—The Jacobs Instrument Co., Bethesda, Md.

Connectors, Switches

L-258 **Connectors.** New 4-page Amform 1977-9220 illustrates and describes maker's "Blue Ribbon" line of rack and panel type connectors. Includes feature, voltage ratings, and applications.—American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.

L-259 **Connectors, Solenoids.** New 8-page Vol. 4, No. 6 issue of "The Cannonade" contains articles on maker's large line of d-c. solenoids, connectors, plugs, test-point jacks, sales growth, and distributor news.—Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.

L-260 **Multi-contact Connectors.** New Vol. 5, No. 8 issue of "Amphenol Engineering News" features articles on use of maker's multi-contact connectors in the "Teleplotter" of Telecomputing Corp., the surface pyrometers of Pyrometer Instrument Co., and other instrument applications.—American Phenolic Corp., 1830 S. 54 Ave., Chicago, Ill.

L-261 **Switches.** New 2-page Data Sheet 64 describes and illustrates maker's low-force switches with lever actuators. Includes characteristics, switches with roller lever actuators, and price information.—Micro Switch, Freeport, Ill.

L-262 **Circuit Breakers.** New 16-page Manual 101 explains and diagrams the operating principles of the 3 basic types of circuit breakers—thermal, thermal-magnetic, and magnetic. Discusses temperature factors, inrush current effects, tripping, and reset time.—Heinemann Electric Co., 305 Plum St., Trenton 2, N. J.

Transistors, Tubes

L-263 **Germanium Transistor.** New tentative data sheets contain description, mechanical data, and electrical data on two types (CK721 & CK722) germanium transistors. Includes dimensions.—Raytheon Mfg. Co., Newton, Mass.

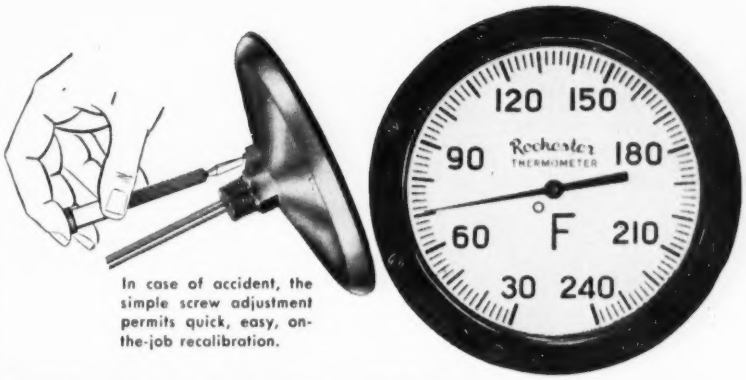
L-264 **Stabilizer Tube.** New 4-page Vol. 1, No. 6 issue of "Engineering Information Service" describes new "Type 40A1" ballast-type stabilizer tube for stabilizing horizontal-deflection circuits. Gives characteristics and ratings. Includes information on UHF TV experimental transmitter.—Sylvania Electric Products, Inc., Radio Tube Div., Emporium, Pa.

L-265 **Medium-Mu Twin Triode.** New 4-page tentative data sheet 6BQ7-A-8-52 describes maker's new "6BQ7-A" low-noise medium-mu twin triode. Includes general data, characteristics charts, design, construction, and dimensional outline.—Tube Dept., RCA, Harrison, N. J.

L-266 **Beam Power Amplifier.** New 4-page tentative data sheet on maker's new "12V6-GT" beam power amplifier gives general data, operating considerations, characteristics charts, and dimensional outline. Includes single-tube and push-pull operation.—Tube Dept., RCA, Harison, N. J.

L-267 **Cold Cathode Control Tube.** New 4-page Bulletin 252 describes and illustrates maker's cold-cathode control tube "Model TT-1." Includes characteristics, ratings, and applications.—Haledy Electronics Co., 57 William St., New York 5, N. Y.

L-268 **Electron Tubes.** New 4-page Application Note 155 covers use of miniature power pentode "RCA-6CL6" in video output stages. New 8-page Application Note 156 discusses electrode-



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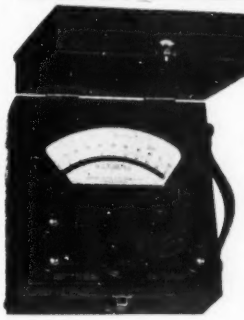

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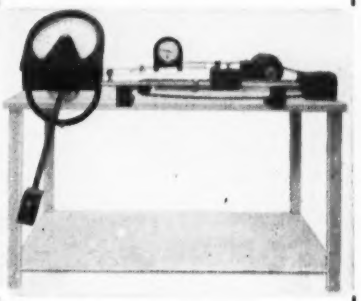

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L-269 **Twin Diode.** New 2-page data sheet describes and illustrates RCA-5726 high-perveance, miniature twin diode "Type 5726" useful as detector in circuits using wide-band amplifiers.—Tube Dept., RCA, Harrison, N. J.

Electrical & Electronic Components

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L-271 **Electronic Components.** New 60-page catalog describes and illustrates maker's sockets, plugs and connectors, jacks, terminal strips, binding posts, knobs, terminal block, standoff insulators, fuse holders and fuse blocks, rack and panel connectors, and watertight and universal binding posts. Includes types and dimensions.—Hugh H. Eby, Inc., 4700 Stenton Ave., Phila. 44, Penna.

L-272 **Electronic Components.** New 8-page folding brochure illustrates and describes maker's line of electronic and electrical components, including terminal lugs, feed-throughs, ceramic boards, coils, etc.—Cambridge Thermionic Corp., 469 Concord Ave., Cambridge 38, Mass.

L-273 **Microwave Components.** New 8-page Catalog 52A illustrates and describes maker's magnetrons and over 80 other microwave products including TR tubes, silicon diodes, waveguide components, and millimeter and centimeter wavelength test equipment.—Microwave Associates, Inc., 22 Cummington St., Boston 15, Mass.

L-274 **Coaxial Accessories.** New 12-page issue Vol. 27, No. 5 of "The Experimenter" illustrates and describes maker's new coaxial accessories: adaptors, line stretcher, component mount, balun, terminations, and insertion unit.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

L-275 **Electronic Components.** New 4-page Dec., 1952 issue of "Allied News" illustrates and describes several new electronic components handled by large distributor, including Raytheon CK-716 transistor, Barber-Colman "Micropositioner" relay, etc.—Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.

L-276 **Synthetic Quartz Crystals.** New 8-page Dec. '52 issue of "Brush Strokes" features an article on the properties of synthetic quartz and their growing technique. Includes instrument notes and information about new magnetic brush heads.—The Brush Development Co., 3322 Perkins Ave., Cleveland, Ohio.

L-277 **Self-generating Accelerometers.** New 6-page article reprint describes and illustrates principles of piezoelectric self-generating accelerometers. Includes characteristics and advantages of compression and bender-type accelerometers using piezoelectric elements.—Gulton Mfg. Corp., Metuchen, N. J.

L-278 **DC-AC Choppers.** New 2-page bulletin Cat. 280B describes and illustrates maker's choppers (electromechanical precision vibrators) for instrument applications requiring conversion of d.c. to a.c. of 10 to 500 cps. Includes applications and specifications.—Stevens-Arnold Inc., 22 Elkins St., South Boston 27, Mass.

L-279 **Wiring and Insulation.** New 12-page illustrated Manual A-4662.10M describes how new science of "Turbonics" aids in solving wiring system and insulation problems. Includes features of 14 types of insulations and wires.—The William Brand & Co., Inc., North and Valley Sts., Williamantic, Conn.

L-280 **Pilot Lights.** New 16-page Form L-151 illustrates and describes maker's large line of enclosed and open pilot light assemblies, sockets, lamps, and lens holders.—The Dial Light Co. of America, 900 Broadway, New York 3, N. Y.

L-281 **Wire Markers.** New 8-page Bulletin 552 illustrates and describes maker's "E-Z Code" wire markers. Includes types and applications.—Western Lithograph Co., 600 E. Second St., Los Angeles 54, Calif.

Packing Glands

L-282 **Midget Packing Glands.** New Bulletin PG-1 introduces maker's new midget packing gland for sealing entry of instrument tubes with dia. of 3/32, 1/8 and 3/16 inch. Includes features and specifications.—Conax Corp., 4515 Main St., Buffalo 21, N. Y.

Miscellaneous

L-283 **Copying Machine.** New 8-page illustrated Booklet A-2042 describes maker's "Model 14 Copyflex" machine for rapid reproduction of papers, charts, etc. Gives operation, uses and features.—Charles Bruning Co., Inc., 125 North St., Teterboro, N. J.

L-284 **Phonograph.** New 4-page bulletin illustrates and describes maker's new phonograph development "Phono-Gard," which protects phonograph pick-up head. Shows applications, operation, and models.—Grayline Engineering Co., 12233 Avenue O, Chicago 33, Ill.

L-285 **Technical Books.** New 4-page index to papers and books in the "RCA Review" series includes reviews of books on TV, electron tubes, UHF, FM, and radio facsimile.—RCA Review, RCA Laboratories Div., Princeton, N. J.

L-286 **Navigation Computer.** New 18-page Winter 1953 issue of "Collins Signal" features article on new navigation computer for aircraft. Other articles are on aircraft design, and aircraft transceiver.—Collins Radio Co., Cedar Rapids, Iowa.

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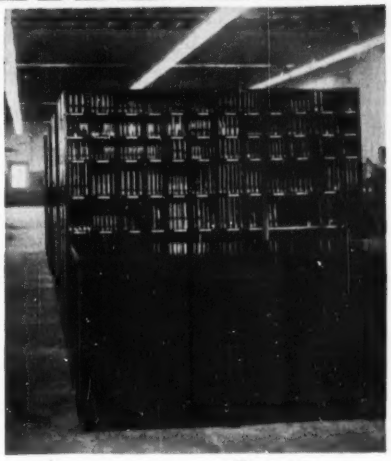

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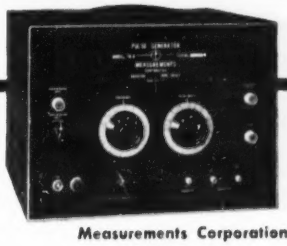

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Mar. 2-6
Pittsburgh Conference and Exposition on Analytical Chemistry and Applied Spectroscopy, William Penn Hotel, Pittsburgh, Pa. For information write L. E. Pitzer, c/o U. S. Steel Co., 525 Wm. Penn Place, Pittsburgh 30, Pa.

Mar. 10
Society for Applied Spectroscopy regular meeting at Socony-Vacuum Training Center—New York. Subject—"Temperature Measurement by Spectroscopic Means." Dr. Shirleigh Silverman, Johns Hopkins University.

Mar. 17-19
121st Meeting American Meteorological Society. Atlantic City, N. J. For information write Kenneth C. Spangler, Ex. Sec., 3 Joy St., Boston 8, Mass.

March 23-26
I.R.E. National Convention & Radio Engineering Show. Grand Central Palace, New York, N. Y. For information write W. Copp, 303 West 42 St., New York 18, N. Y.

Mar. 23-25
13th Annual Meeting, American Congress on Surveying and Mapping, Hotel Shoreham, Washington, D. C. For information write Walter Dix, Ex. Sec., Box 470, Benjamin Franklin Sta., Washington 4, D. C.

Mar. 26-27
Instrumentation for the Iron and Steel Industry, Roosevelt Hotel, Pittsburgh, Pa. For information write Dr. Axel H. Peterson, Secretary, Pittsburgh Sec., Instrument Society of America, c/o Mellon Institute, 4400 Fifth Ave., Pittsburgh 13, Pa.

April 3
Symposium "Management, Labor and the Instrument Department." Hotel Essex House, Newark, N. J. For information write L. H. Ballinger.

April 7
Fifth Annual Symposium, New Jersey Section, Instrument Society of America, entitled "Management, Labor, and the Instrument Department." Hotel Essex House, Newark, N. J. For information write L. H. Ballinger, 2371 Channing Ave., Westfield, N. J.

April 29, 30, and May 1
Electrical Components Symposium to be held at Shakespeare Club, Pasadena, Cal. Sponsored by American Institute of Electrical Engineers, Radio Engineers, Radio-TV Mfgrs. Asso., and West Coast Electronic Mfgrs. Asso. For Information write Dr. A. M. Zarem, Stanford Research Institute, Suite 1011, 621 S. Hope St. Los Angeles 17, Cal.

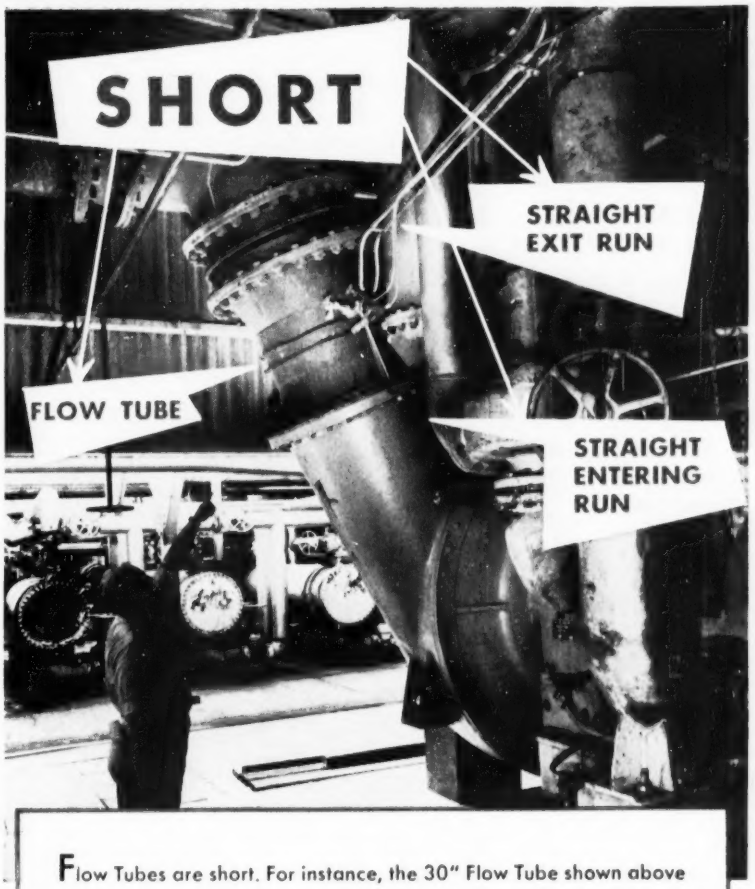
May 1
American Association of Spectrographers symposium on "Emission Spectroscopic Determination of Metals in Non-metallic Samples" in Chicago. For Information write Mr. J. P. Pagliassotti, c/o Standard Oil Co. (Indiana), Box 431, Whiting, Ind.

May 24-28
Annual Meeting of all Sections, STMA, The Greenbrier, White Sulphur Springs, W. Va.

May 27-29
Annual Meeting, American Society for Quality Control, Bellevue, Stratford Hotel, Philadelphia, Pa. For information write Alfred L. Davis, Ex. Sec., 70 E. 45 St., New York 17, N. Y.

June 30-July 11
Second British Instrument Industries Exhibition, National Hall, Olympia, London, England. For information write E. L. Bols, Grand Buildings, Trafalgar Square, London, W.C.2, England.

September 21-25
Eighth National Instrument Conference & Exhibit, Sherman Hotel, Chicago, Ill. For information write P. V. Jones, Mgr., Instrument Society of America, 1319 Allegheny Ave., Pittsburgh 33, Pa.



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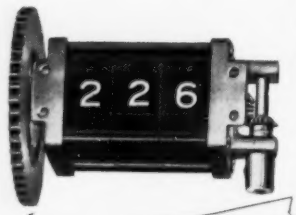

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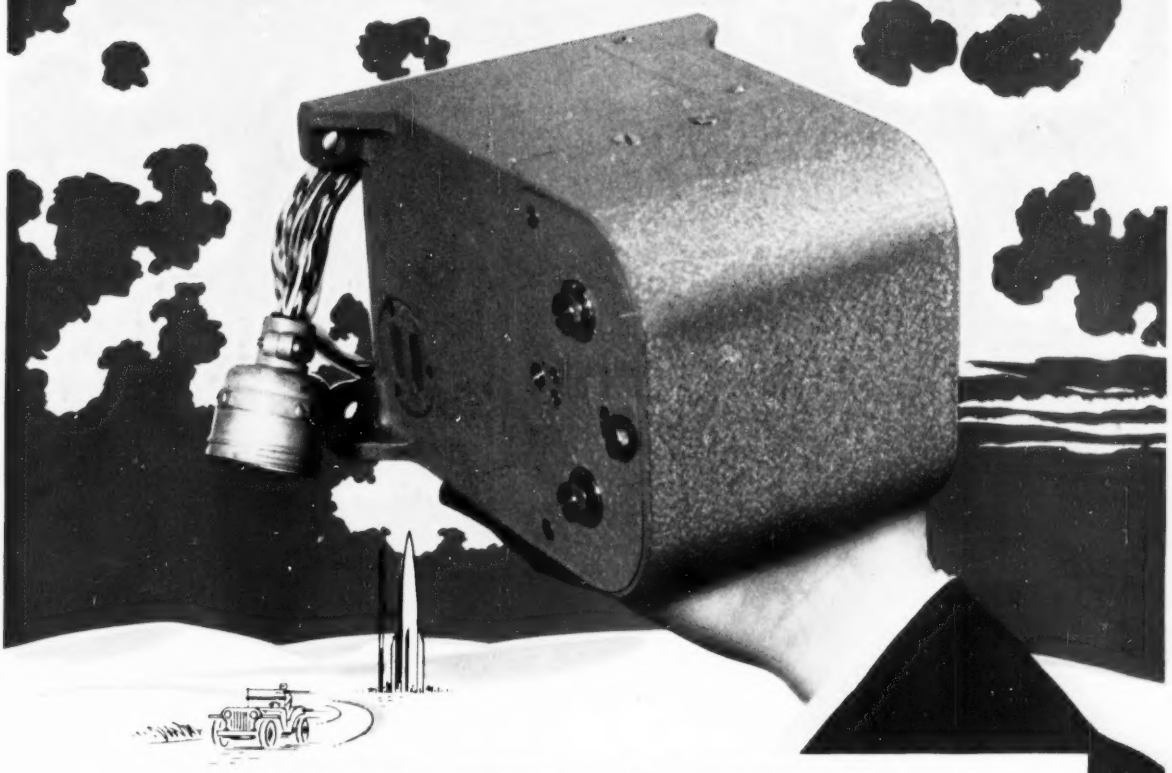

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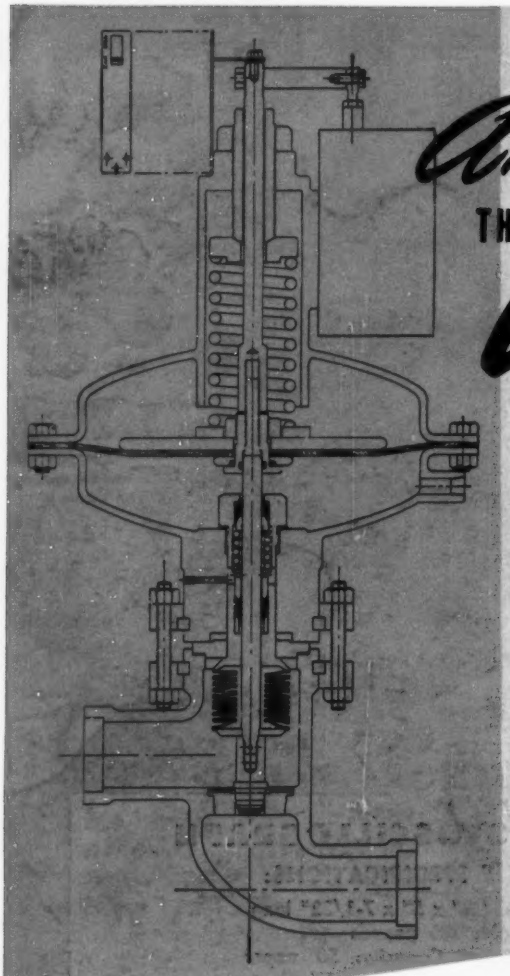

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